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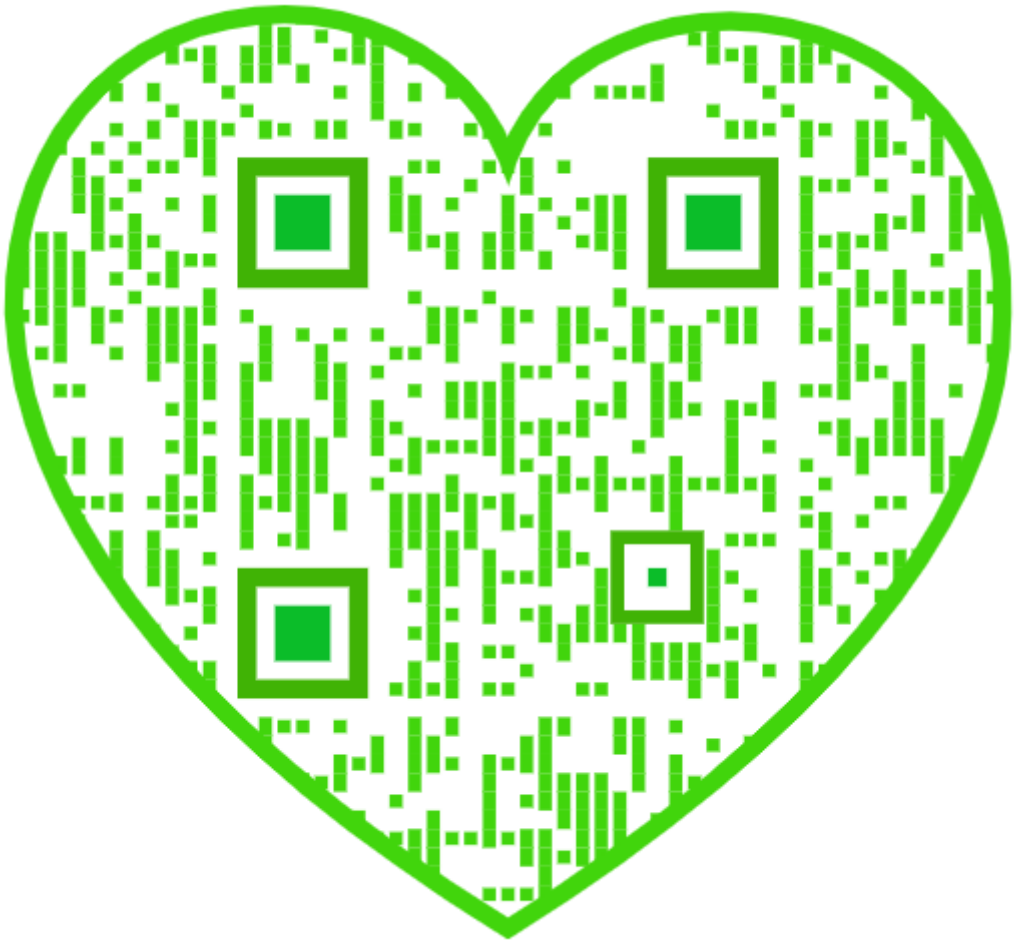

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By Alois Senefelder

Translated from the Original German
by J. W. MULLER

THE INVENTION OF LITHOGRAPHY

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BY

ALOIS SENEFELDER

TRANSLATED
FROM THE ORIGINAL GERMAN BY
J. W. MULLER

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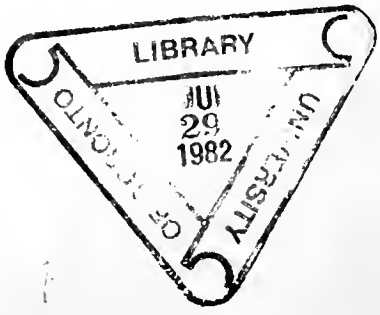

TRANSLATOR'S PREFACE

ALOIS SENEFELDER, not only the inventor, but the father and perfecter of Lithography, wrote this story of his life and his invention in 1817. The translator has followed his style closely, because he felt that the readers would prefer to have this English edition represent Senefelder's original German faithfully.

When Senefelder wrote, he had to invent many names for the processes, manipulation-methods, and tools. These terms have been translated literally even where modern practice has adopted other names.

The original German edition carried the following title-page: —

"Complete | Text-Book of Stone-Printing | containing | a Correct and Lucid Instruction | for all | Various Manipulations in all its Branches and Methods | and also a | Full History of this Art | from its Origin to the Present Day. | Written and Published | by the Inventor of Lithography and Chemical Printing, | Alois Senefelder. | With a Preface by the General-Secretary of the Royal Academy of Sciences in | Munich, the Director | Friederich von Schlichtegroll | Munich, 1821 | Obtainable from the Author and from E. A. Fleischmann" |

The book was dedicated by Senefelder to Maximilian Joseph, then King of Bavaria.

July, 1911.

J. W. M.

PREFACE

A BOOK like this requires no preface; it makes its own way, supported by its contents. But the famous author deems that his acquaintance with me gave him the direct impulse for producing this work, which has been desired so long and from all sides; and he wishes that I shall say something about the history of its production. I seize the opportunity gladly to prove the esteem and the friendship that the talent of this honorable contemporary and fellow countryman, a talent combined with the utmost ambition and with childlike good nature and unselfishness, have inspired in me.

One may not declare that his contemporaries showed indifference to the invention of lithography to which his fortunate star led Herr Alois Senefelder, and to the improvements that he sought with thousands of experiments and restless labor. On the contrary, the invention has spread itself with surprising speed through Europe and beyond, and has been received with admiration everywhere. But the lack of proper instruction, due to the many who had learned it only partially and introduced it only for the sake of a small, passing profit, has hampered its perfect success.

Therefore the inventor, who, happily, still lives among us, has been urged from near and far to tell the story of his important, many-sided discovery, and to give instructions for its use, that is, to produce such a work as is before us now.

But the artistic genius, full of his subject, would far rather work, experiment, strive, than write! Many times Herr Senefelder decided to set down how he happened on this art, how the successive steps of its development were reached, and at what point of development its various processes now stand; but always his ceaselessly striving spirit showed him something new that might be achieved, and forced him back again into his element, —experimentation.

Thus the "Pattern Book," begun in 1809, remained unfinished and without text; and the other work, announced two years ago by Herr Andre, in Offenbach, as being undertaken by him with Herr Alois Senefelder, hardly would have seen the light.

A forceful impetus from without was needed to compel Herr Senefelder to fulfill the general request of the public. It came as follows. Many statements in print attracted my attention. They credited the invention of lithography to Paris, to London; and in Munich there were various contradictory legends, some alleging that Herr Alois Senefelder had made the very first experiments and others crediting them to Herr Schmidt in Miesbach, at that time Professor in Munich. I considered it my duty to clear away this uncertainty and to prepare a critical history of this invention while it still was possible.

The weekly *Anzeiger für Kunst und Gewerbfleiss* in the kingdom of Bavaria, which has appeared since 1815, exists for the purpose of producing annals of the art and industrial history of Bavaria. Therefore, toward the end of 1816 and early in 1817, I inserted some letters about the invention of lithography and called on all friends of native art history to point out any inaccuracies and send proofs to the contrary, that the truth might thus be ascertained about a subject of great literary value for this generation and for posterity. More than all, I urged Herr Alois Senefelder, then absent, "to produce a detailed history of his invention as soon as possible, with a text-book embellished by specimen plates, in which the full use of the art might be truly and clearly explained." I sent this printed letter to Herr Senefelder in Vienna.

The first object of my request has been without much result. Hardly a single voice has been raised to uncover the correct and the incorrect in the various stories with strictly historical accuracy, and thus to bring the truth to light, that lithography may not experience what our Klopstock sings: "Too oft in eternal night is cloaked the inventor's great name!"

I have been more fortunate in my second object. Herr Alois Senefelder recognized my good intention and my pure pleasure in this important art that will give our Bavaria unending fame and spreading celebrity. Since

his return to Munich, it has been the subject of many conversations between us, and I have endeavored to enliven the courage and self-confidence of this remarkable man, who often was depressed by the failure of many an enterprise.

My three endeavors — to win the gracious attention of our most high royal family for the latest improvements in chemical printing attained through Herr Senefelder's work; to impel the venerable national institution to which I belong to investigate the art scientifically; and the publication of the text-book and the history of the inventor — these have been not without result.

His Majesty, our most gracious King, this all-honored Father of his nation and his people, and long a gracious promoter of lithography, has taken gracious cognizance of the newest, amazing experiments in metallography and papyrography with which Herr Senefelder busied himself last winter, has encouraged him magnanimously to publish the present work, and has permitted that it shall be dedicated to his noble name. Her Majesty, our supremely honored Queen, herself a connoisseur in the creative arts, also has honored these experiments with her gracious attention, and thus has enlivened the courage and the energy of the artist.

The most celebrated technicians in the Royal Academy have examined these processes and also the various small presses lately invented by Herr Senefelder in order to make stone-printing, and also metal and paper printing available for private use and business, and have given him the most flattering testimonials. The Polytechnic Association of Bavaria also has aided, through its before-mentioned weekly publication, in making Herr Senefelder and his art, and especially his most recent achievements, known in a wider field than might otherwise be possible, and to bring him to the attention of his fellow citizens and interested travelers.

At last, Herr Alois Senefelder has used the hours that he could spare from his continuous experiments and investigations to write down the history of his labors out of his faithful memory; and also to give a full description of all methods invented by him to this time, accompanied by highly instructive specimen pages, partly made by himself and partly by

artistic friends, but all printed either with his own hand or under his direct supervision.

Thus with the past winter there developed a new, still more busy life of this rare, useful man; and thus there originated the present work that I do not hesitate to declare as belonging among the most noteworthy productions of the present Leipsic Book Fair.

The book is in two parts: (1) the history of the invention and of the various applications of the new art: (2) the description of the methods for writing, drawing, engraving, transferring, etching, and printing, stated with all the clearness possible, and accompanied with object-lessons in the form of wonderfully successful and instructive specimen plates.

With the great candor inherent in the character of the author he tells faithfully how he came to make his first experiments, what mistakes he made, with what inner and outer difficulties he contended, how one idea led to another, what combinations he tried, what plans, successful and unsuccessful, he made, and under what unrest and embarrassments he lived for many years.

The minute detail of the history and the interpolation of the personal relations of the author and his acquaintances may surprise many readers at first sight; but many of these are intimately connected with the development of stone-printing, and in the cases of others, the author did not have time to re-write what really had been written as only the first draft, because his original intention of re-writing would have prevented the appearance of the book in the present Easter Book Fair.

In the history of an important invention, minuteness hardly can be called a fault. How gladly would we read all the family circumstances of Johann Guttenberg and Johann Fust, if there were such a history of the beginnings of typography as now is before us about lithography!

Thus there has been fulfilled the desire that Herr Alois Senefelder tell openly and plainly how he came to discover stone-printing. Now that his testimony and claims lie open to all eyes, it is possible to compare it with the other stories that are told, and to bring the necessary accuracy into the investigation by sharply defining those things that properly may be called

stone-print. It is time to urge contemporaries once more to declare anything known to them that is in contradiction of this history, so that a critical history of stone-printing may be produced, with a chronicle of what was done in the early years of the art, how and by whom, so that we may learn if several minds had the idea simultaneously, and thus to do justice to all. It is to be desired that a writer equipped for the purpose with total non-partisanship, utter truthfulness, and clearness of perception and judgment may do this not unimportant service to literature very soon!

As to the text-book, forming the second part of this publication, it has been demanded even more than the history.

Stone-printing has spread so much in recent years that a few certain lithographers could no doubt give satisfactory instruction. But there is only one voice among those who are acquainted with the matter thoroughly, and that is, that Herr Alois Senefelder made not only the earliest but the most numerous and various experiments, and therefore is the foremost man to give instruction.

He is of an upright spirit, and I can assert with full conviction that in this text-book his aim was not only to tell everything fully, but also with the utmost accuracy. Already he has instructed many in the art, trained many others, and thus has learned what are the circumstances that ordinarily hinder the efforts of a beginner.

Even recently, according to his statement and that of Professor Mitterer, whom I consider the best expert in lithography next to Senefelder, there still have been phenomena that surprised lithographers most unpleasantly in the midst of a piece of work, and ruined results as if by witchcraft, — cases wherein, in two apparently perfectly similar manipulations, there would not succeed to-day that which had succeeded yesterday, nay, even an hour before. The text-book gives all explanations and remedies for such cases that the wide experiences of Senefelder have made known to him. Therefore, if an artist proceeds exactly according to the instructions given here, and yet meets obstacles, he need merely look for the reason in some small, unnoticed detail or in the quality of his materials. He need

not become discouraged, for if he has faith in his faithful and candid teacher, he will attain the goal.

Besides the branches and methods already known and practiced with success outside of Munich, as in Karlsruhe, Stuttgart, Berlin, London, Paris, etc., this text-book teaches several methods that had not been made public by the inventor till now; and the fundamental principles of those methods already known are stated here solidly. He gives information also of his most recent attempts to use metal plates as well as the stone paper recently invented by him.

Although the procedure in these two latter methods resembles stone-printing largely, it differs so much in some points from real lithography that Herr Senefelder proposes to publish a work about these processes especially, which may then serve as a supplement to this one.

So may this work go forth in the world under good auspices, to increase the fame of its author, secure for him the respect of all friends of art in and outside of Germany, and become an encouragement for him to dedicate his life further to his greatly promising art and its fullest development!

Honor in rich measure has come to him already through his art. A worldly wise man in his place would have become a wealthy one. That he is not; but our magnanimous King has made him secure against want during his remaining life, and my knowledge of his character assures me that he will utilize this, and any other advantage that may accrue to him in time to come through this work or his art, for perfecting it, and then to train his only son, now five years old, to the art, so that he may practice it in future with honor to his father's name.

FRIEDRICH VON SCHLICHTEGROLL.

MUNICH, EASTER DAY, 1818.

SECTION I

HISTORY OF STONE-PRINTING

PART I

FROM 1796 TO 1800

AS my father, Peter Senefelder of Königshofen in Franken, was court actor in Munich, I had ample opportunity in early youth to see and read many theatrical pieces. Thus I developed such a love for this branch of literature and for the theatre that I would have become an actor myself had I been permitted to obey my inclination. But my father, who was determined not to permit any of his children to choose the stage, compelled me to study law. I could satisfy my longings only occasionally by playing a few times in private theatricals and by venturing on a few dramatic writings in my hours of recreation. In my eighteenth year (1789) the question arose, at a gathering of youngsters, as to how we should entertain ourselves in the approaching Carnival time. We decided to give a little private play.

Many pieces were proposed, but none seemed suitable, because each one wished to play a good and suitable part, and, besides, we could not fill most of the parts, as we lacked women. We were almost giving up hope when Herr Kuerzinger, now court actor, proposed to me to write a play, as I had begun one shortly before that happened to suit each of my friends.

I finished the little piece, *Die Mädchen Kenner*, in a short time. It was ready for production, when through accident we were disappointed about securing the private theatre on which we had counted. We were emboldened to request leave to produce it in the Kurfürst's Court Theatre and succeeded, thanks to my father's aid. The over-kind praise which it won encouraged me to have the play printed. Although I was pretty generous

with free copies among my friends, I received so much from Lentner, the book-dealer in Munich, that a net profit of fifty gulden remained to me.

I had not worked eight days on the little thing, and had made all this money, without counting the pleasure of the work. No wonder that now I feared no longer for my future! My love for the theatre became overpowering, and as my father died soon afterward (1791), and I found no further assistance toward completing my studies in Ingolstadt, I resolved to become a dramatic author and actor.

I found no place for me in the Court Theatre. Its leaders were opposed to my family, because my mother with her large family received a larger pension, through the favor of the Kurfürst, than she could have expected in ordinary course. In a few strolling theatres, such as Regensburg, Nürnberg, Erlangen, and Augsburg, where I endured privation and misfortune enough, my enthusiasm was well dampened in the course of two years. I decided, as I could see no other prospects for the moment despite my not inconsiderable attainments, to support myself in future as author.

I had written several dramatic pieces already that had won sufficient applause. Therefore I decided to have some of these printed in order to meet my immediate expenses. I gave one of them to the printing establishment of Herr Hübschmann, in Munich, and when the first folio was finished, I made the proposition to Herr Lentner to take some or all of the copies. He told me that I would have done better to let him have the manuscript; but since it had been begun, he told me to make sure that it be finished before the beginning of the Leipsic Easter Fair, in which case he promised to obtain for me one hundred gulden net, after deducting all costs. I begged Herr Hübschmann to finish the printing, but, as he assured me that it was impossible, I took the remaining folios to another printer. Despite this the play was not printed till two weeks after the fair, and I received from Herr Lentner barely enough to pay the printing cost.

My hope of profit was lost. I had, however, seen the entire procedure of printing, because I had spent many a day in the establishments. I found that it would not be hard for me to learn, and could not withstand the desire to own a small printing establishment myself. "Thus," thought

I, "I can print my productions myself, and so alternate healthfully between mental and physical activities." I could earn a decent living, too, and thus become an independent man.

This idea controlled me so that I studied all sorts of ways to realize it. If I had possessed the necessary money, I would have bought types, a press and paper, and printing on stone probably would not have been invented so soon. The lack of funds, however, forced me to other expedients. At first I thought of etching letters in steel. These matrices I planned then to impress on pear wood, in which the letters would show in relief, somewhat like the cast type of the book printers, and they could have been printed like a wood-cut. A few experiments showed me the possibility of this, and I could easily have invented a machine with which the moulding could have been done more quickly than a printer could set his type. I reserve the right to use this possibly fruitful idea in future with improvements. At the time, however, I had to give up the whole thing through lack of implements and sufficient skill in engraving.

Then it struck me that if I had only enough types to set one column or folio, I could press this into a soft material, transfer the impression to a board covered with soft sealing-wax, and reproduce the relief plate thus obtained in stereotype form. The attempt succeeded perfectly. I made a sort of dough of clay, fine sand, flour, and coal-dust, which, being firmly kneaded, took the impression very well, and was so dry in a quarter of an hour that I could print warmed sealing-wax thoroughly well with a small press. I inked these letters of sealing-wax relief with printing-ink laid on with a leather roller stuffed with horse-hair and obtained a result as clean as any obtained from ordinary types. By mixing finely powdered gypsum with the sealing-wax I made the latter harder than the ordinary type composition. Thus there was nothing in the way of my making stereotype plates (which I did not know by this name at that time), except a few minor appliances and a small stock of types. But even this exceeded my financial power and I gave up the plan, especially as I had conceived a new one during my experiments.

This was to learn to write out ordinary type letters exactly, but reversed.

I planned that as soon as I attained the skill, I would write them with an elastic steel pen on a copper plate covered in ordinary manner with etching surface, etch, and let the copper-plate printers print them. In a few days I had such skill in reverse writing that I attacked the etching on copper bravely. Here, to be sure, I met greater difficulties. Writing on copper over the etching surface was far more difficult than writing on paper. Then the preparation of the plate, the etching, etc., demanded some practice; but all this I hoped to conquer in time. The one thing that troubled me was that I could not correct the errors made during writing. The accessories of copper-plate engravers, especially the so-called cover varnish, were quite unknown to me. I knew no remedy except to paint the faulty places over with molten wax, but the covering generally became so thick that I could not work through it properly and had to leave the corrections for the graving stilus, which, however, I could not handle at the time.

As, however, the proofs were thoroughly satisfactory to me, I labored desperately to overcome the difficulty. During my student years I had attained much chemical knowledge, and I knew that most of the resinous products which withstand acid, as well as the fats, wax, tallow, and so forth, can be dissolved and diluted partly in etheric oils and spirits of wine, and partly in alkalies. My problem was to obtain a thin mass which would permit itself to be spread very thinly in cold condition over the copper etching surface, dry quickly, become sufficiently firm after drying without getting tough, and, above all, be something that would not attack the etching surface. A few trials with spirits of wine and various resinous forms gave no satisfaction. The one experiment that I made with oil of turpentine and wax also failed, presumably because I diluted the mixture more than necessary, which caused it to flow too much and dissolve the etching surface, at which time several well-done parts of the engraving were ruined. Besides, this mixture dried only slowly to the degree necessary for working. Fortunately I made no further experiments with this material, because then I should not have invented stone-printing, as I know now how to make a cover varnish that is quite satisfactory.

I turned, instead, to an experiment with wax and soap, which succeeded beyond all expectations. A mixture of three parts of wax with one part of common tallow soap, melted over the fire, mixed with some fine lamp-black, and then dissolved in rainwater, gave me a sort of black ink with which I could correct faulty spots most easily.

Now I needed only practice in order to carry out my project of etching my literary productions in copper. This presented a new difficulty. After I had written on my single little copper plate, etched it, and pulled proofs at the house of a friend who possessed a copper-plate press, I had to spend some hours again laboriously grinding and polishing the plate, a process which also wore away the copper fast.

This led me to practice on zinc, which was easier to scrape and polish. An old zinc plate of my mother's was requisitioned at once, but the results were very unsatisfactory, because the zinc probably was mixed with lead, and I had used only aqua fortis instead of more powerful acid.

I did not continue trials with zinc, because just then I obtained a handsome piece of Kellheimer stone for the purpose of rubbing down my colors on it; and it occurred to me that if I painted this stone plate with my wax ink, it would serve as well for practicing as copper or zinc, with very little labor in grinding and polishing. The experiments succeeded, and though I had not thought originally that the stone itself might be used for printing (the samples I had seen hitherto of this Kellheim limestone were too thin to withstand the pressure exerted in printing), I soon began to believe that it was possible. It was much easier to do good work on the stone than on the copper. I observed also that I needed weaker and much diluted aqua fortis.

A stone mason told me that he could provide me with this sort of limestone in plates from one inch to eight inches thick. Thus I needed not to fear cracking of the stone; and the only thing that I needed to invent, in order to use the stone just like copper, was either a way to give the stone a better polish, or else a tint which would be easier to rub away than the ordinary copper-plate printing-ink. The stone will not take the polish that is demanded with ordinary printer's ink,—and perhaps this is the reason

why the stone has not been used long before my time as substitute for copper, for I imagine that such attempts must have been made.

I tried all possible kinds of polishing and grinding without attaining my purpose completely. The result was best when I poured a mixture of one part of concentrated oil of vitriol and four or five parts of water over the stone after polishing it. This mixture, which is very sharp, has the property of boiling immediately when poured over the stone, but ceasing instantly, so that one is tempted to believe that the vitriol has sated itself and lost its power. This is not so, however; for the same fluid, placed on an untouched part of the stone, boils again at once. The reason is that a firm skin of gypsum forms at once on the stone, and this remains impervious to the fluid. If now the etching fluid is poured off and the stone is rubbed lightly with a rag, it attains a shining polish. Unfortunately this is so thin and weak that one can make barely fifty impressions without repeating the process, which involves some loss to the drawing. But if one desires to print in the present chemical style, that is, wet, and the stone is polished before the drawing, one can make several thousand imprints, which will be described in the proper place.

All experiments to find a color easy to wipe away showed me that on a stone prepared with oil of vitriol none was better than a light oil varnish with fine Frankfurter black and some tartar. This mixture could be washed off with a weak solution in spring water of potash and common salt. However, it happened often that slight carelessness in washing destroyed designed parts which took color again afterward only after much trouble. Recollection of this occurrence, which I could not understand clearly at the time, led me some years later to the invention of the chemical stone-printing of to-day.

I have told all these things fully in order to prove to the reader that I did not invent stone-printing through lucky accident, but that I arrived at it by a way pointed out by industrious thought. It will be seen that I knew the ink, before I thought of its use on stone. The stone I used at first only to practice writing. The ease of writing on stone lured me then to try to make it available for direct printing. To do this, I had to discover a way

to rub away the black as completely from all unetched parts of the stone as the copper-plate printer can do it from his surface, in comparison with which the stone was but slightly smooth.

At this time my further experiments with this etched form of stone-printing were entirely checked by a new, accidental discovery. Until now I had invented little that was new, but simply had applied the copper-plate etching method to stone. But this new discovery founded an entirely new form of printing, which basically became the foundation of all succeeding methods.

Had the stone merely proved available as substitute for copper, I would have returned to copper as soon as I could afford it, despite several advantages of stone, and for the following reasons: first, the necessary weight and thickness of the stones; second, because the printing process was slower than with copper; third, because probably I never would have become sufficiently skilled in the difficult manipulation of washing off; but chiefly, because the necessary spur, the originality of the discovery, would have been lacking, since I remembered that as a child of five or six I had seen a music-printery in Frankfurt or Mainz where the notes were etched in black slate-stone. I had played often with the broken stones, which lay in a heap near our house. Enough, I was not the first discoverer of stone-etching, nor of stone-printing; and only after I made this new discovery which I will describe now, which led me from the engraved to the relief process, with my new ink, might I call myself the inventor of an art.

At that time I could not guess that I was to invent a form of printing different even from this new and original form, a method which was to be based not on mechanical but purely chemical properties. Even this method, new in 1796, still was purely mechanical in its purpose, whereas the present printing method, which I began in 1799, may be called purely chemical.

I had just ground a stone plate smooth in order to treat it with etching fluid and to pursue on it my practice in reverse writing, when my mother asked me to write a laundry list for her. The laundress was waiting, but we could find no paper. My own supply had been used up by pulling proofs.

Even the writing-ink was dried up. Without bothering to look for writing materials, I wrote the list hastily on the clean stone, with my prepared stone ink of wax, soap, and lampblack, intending to copy it as soon as paper was supplied.

As I was preparing afterward to wash the writing from the stone, I became curious to see what would happen with writing made thus of prepared ink, if the stone were now etched with aqua fortis. I thought that possibly the letters would be left in relief and admit of being inked and printed like book-types or wood-cuts. My experience in etching, which had showed me that the fluid acted in all directions, did not encourage me to hope that the writing would be left in much relief. But the work was coarse, and therefore not so likely to be under-cut as ordinary work, so I made the trial. I poured a mixture of one part aqua fortis and ten parts of water over the plate and let it stand two inches deep for about five minutes. Then I examined the result and found the writing about one tenth of a line or the thickness of a playing-card in relief.

A few finer strokes had been injured slightly, but the others had hardly lost breadth noticeably and not at all in depth, so that I had good reason to hope that a well-written plate, particularly in type letter, would be susceptible of much better relief.

Eagerly I began inking in. I used a fine leather ball, stuffed with horsehair, and inked it very gently with thick linseed oil varnish and lampblack. I patted the inscription many times with this ball. The letters all took the color well, but it also went into all spaces greater than half a line. That this was due to the over-great elasticity of the ball was clear to me. So I cleansed my plate with soap and water, made the leather tense, and used less color. Now I found color only in such spaces as were two or more lines apart.

I saw that I could attain my purpose better with a dauber of stiffer material. I tried at once with a piece of glass from a broken mirror, and as this succeeded fairly well, I tried elastic metal plates. Finally I made an entirely satisfactory appliance out of a thin board, very smoothly planed and covered with a fine cloth.

My further experiments with this relief plate succeeded far better than my previous ones with etched letters. The inking in was much easier, and hardly one quarter of the force was necessary for making impressions. Thus the stones were not so liable to crack, and, what was the most important for me, this method of printing was entirely new, and I might hope to obtain a franchise and even financial aid. This hope grew when I learned that Riegel of Munich, who had invented a new sort of Frankfurter black, had received ten thousand gulden to erect a factory, although no human being could use it as a sufficient substitute, as I proved by many trials. I saw the great field for my stone-printing art and did not doubt that I would obtain assistance, even should it be only a twentieth part of what Herr Riegel had received for his entirely worthless process.

The new art was invented, and soon was sufficiently practised; but again came the need for a little capital, to buy a press, some stones, paper, tools, and so forth. If I did not wish to give up my hopes again, I must seek some way to obtain the necessary means. All my endeavors were fruitless. Only one way showed itself. An acquaintance, who served in the artillery, had offered to pay two hundred gulden for a substitute. In my helplessness I offered myself. I thought: "Once you are in the artillery and have mastered the exercises, you can get furlough and the permission to do your printing. You can pay others to do your sentry goes, and thus there will be only a few weeks a year in which the regiment will demand your presence. As soon as you have earned a few hundred gulden you can get a substitute yourself, or, at worst — how soon six years will pass! Perhaps you can make your fortune in the artillery, too! You will display zeal, and your knowledge is such that probably few in the corps will be superior to you. Mathematics, and especially mechanics and geography, were ever your favorite studies; you were one of the first of the Munich Lyceum in these branches; therefore it is certain that you will be noticed and promoted" — and other such chimerical hopes.

On the third day I went with a transport of recruits to Ingolstadt, which then was the quarters of the Bavarian artillery. I entered that city with feelings different from those with which I had left it as Academician. But

the thought of my invention elevated my spirit to a certain dignity and comforted me with the prophecy of a better future. I was presented to the chief of company and slept a night in the barracks, where unpleasant remarks and the conduct of a vulgar corporal cast heavy shadows over the coming soldiering. Next morning, when I was to be enrolled and named Prague as my birth-place, I was informed that a recent royal order shut out all foreigners from the Bavarian service. So I started on my return, poorer by a hope, but not in entire despair. As I looked down from the Danube bridge into the majestic stream, where as a student I was nearly drowned once, I could not quite prevent the thought that my rescue at that time had not been fortunate, since a too unkind fate seemed to deny me even the one means of support, open to the most helpless, that of the army.

Still, though cheated by hope a thousand times, I ever followed her lures again, and a new plan instantly formed itself to replace the one that had just gone to wreck. I decided to give up my literary work for the time being and work as a printer for wages.

Some very badly printed music that I bought in Ingolstadt awakened the idea that with my new printing process I could furnish much better work. I decided to go at once to Herr Falter, the music-dealer of Munich, to interest him in my invention and obtain a small advance of money. Had I done this, my art might have been more thoroughly perfected long ago; but, again, it might never have been developed as it has been, for it was amply sufficient already for music-printing. My shyness, however, prevented me from addressing Herr Falter. Twice I was at his door, and each time I retreated. The second time I met a good acquaintance, a musician named Schrott. In reply to my inquiry if he knew Herr Falter, he said "No," but he told me that the court musician, Gleissner, had paid recently to have several masses printed and intended to publish some more church music soon. Who was happier than I over this news!

Herr Gleissner was a good friend of old. While I was in the theatre I had engaged him to compose several songs, and had found him a humane and righteous man. Within half an hour I was in his house and explaining my invention to his wife, he being absent. I aroused her interest so much

that she seemed thoroughly eager to have me hurry back with a little press model, in order to show them both the working of the process.

The entire behavior of the woman was so open and artless that I dismissed my first thought, "I might be cheated out of my invention," and hurried to Herr Gleissner in the afternoon with my simple apparatus.

My printing succeeded absolutely. Gleissner marveled at the swiftness and beauty of the impressions, and, knowing my penniless condition, he offered of his own free will to pay for a small printery.

My mother had given me a press already. It was the ordinary copperplate press with two cylinders. True, it was very roughly made, being a house carpenter's work, but it had cost only six gulden. However, one could make very pretty impressions from stone with it. To spare Herr Gleissner's treasury, I contented myself with it for the time. I bought a small stock of stones, paper, and other necessary articles.

Herr Gleissner composed twelve songs with clavier accompaniment. I wrote them rapidly on stone and made one hundred and twenty impressions with the aid of a day laborer. Everything, composition, writing on stone and printing, was finished in fourteen days. From Herr Falter, who bought one hundred copies, Herr Gleissner received the sum of one hundred gulden. Stones, which could be used over and over again, paper, color, and wages had cost barely thirty gulden; thus we had a clear profit of seventy gulden, earned in fourteen days, and I gained so much happy hope that I thought myself richer than Crœsus.

We were gay and merry. Through his patron, Count von Törring, then President of the Royal Chamber, Herr Gleissner had presented an impression of our first work to the Kurfürst Karl Theodor, and had received one hundred gulden out of the Cabinet Treasury, with the promise of a franchise.

A succeeding little piece of work, "Duets for Two Flutes, by Gleissner," brought forty gulden more into our chest, and finally our finances, as well as a bright success for our institution, seemed assured by a contract closed with the Countess von Herting to print a cantata on the death of Mozart

by Cannabich, the musical director, which promised us a profit of one hundred and fifty gulden for two or three weeks' work.

During this time I had presented specimens of work to the Royal Academy of Sciences, with a description of the advantages of the art, in which I named particularly the cheapness, and said that the impression had been made on a press costing not more than six gulden. To my amazement, instead of the expected honorable mention, I received a sum of twelve gulden from the vice-president of the Academy, Herr von Vachiery, with the information that the members had voted favorably for my invention, and that, as my expenses amounted to only six gulden, according to my own statement, I would, no doubt, be satisfied with a sum double this. I had expected an entirely different appreciation from the sentinels of the arts and sciences, whose office was to test the value of this new discovery and call the Government's attention to it if favorable. A mere monetary reward, therefore, especially so small a one, could not possibly give me much pleasure.

Promising as our beginning was (1793), there came a sad period soon enough for the art, for me, and also for Herr Gleissner. We had ordered a new press as soon as our income permitted. I expected to produce a masterpiece with the first impression. Instead of that, there appeared the very opposite, a dirty and smeared imprint. We suspected that we had made some mistake in method. The second attempt, however, was worse than the first, if possible. To be brief, of twenty trials, made with the greatest industry and toil, we obtained only two or three that were even average.

As long as I live I shall be unable to understand how we could have been so blind at that time. We sought the cause of failure in everything except the true thing, —an alteration that made the new press different from the old one, which unfortunately had been already destroyed. Later, after I had invented the so-called lever or gallows press, the thing was clear to me at once. But by that time it had cost me and Herr Gleissner two years full of toil, worry, and sorrow. In the contract with the Countess von Herting the date of completion of the work had been stipulated, because she wished to surprise Herr Cannabich with it on his birthday. We had barely four

weeks left and not a single sheet had been finished. With press alterations, trial impressions, and so forth, we had wasted money and time, and paper by the ream. Our loss amounted to more than one hundred and fifty gulden, and still there was no prospect of final success. Pressed for results by the Countess, our entire reputation and the honor of my invention were at stake. Added to this came many other annoyances, especially the complaints of Frau Gleissner, who charged that I had destroyed the original, perfectly satisfactory press against her will. These tested my courage sadly.

The cause of all this trouble was so petty that I really must have been half-stupefied by the fear of not keeping our pledges, otherwise I must have perceived it at once.

To make my first imperfect press I had bought a piece of wood from a wheelwright in order to have it turned into two cylinders. Hardly had the two been in the house a day before each one split so that a longitudinal crack of two inches width appeared. As the upper cylinder was thick enough to make an impression of a whole folio of sheet music without revolving so far as to let the crack reach the stone, I contented myself with it temporarily. Now, in order not to spoil the impressions, I had to begin each revolution of the cylinder at the crack, for otherwise the crack might have come at the middle or end of the impression and given no imprint of that part. Therefore, as the stone was pushed under the cylinder at the crack, it was already gripped before the impression began, and was drawn through at once. With the new press, however, the upper cylinder had to draw the stone between both cylinders in order to bring it under its pressure. But in doing this, the new press first pulled the linen stretched over the printing-frame till it would yield no more and forced the stone powerfully under the cylinder, during which of course the paper under the linen was pulled over the inked stone and smeared.

Several attempts to rectify this trouble were unsuccessful. Probably I would have discovered the remedy finally,—either that the upper cylinder must not first be pressed on the stone, which must be under it before each impression began, or that I need only use tightly stretched leather

instead of linen. But I decided, instead, in order to complete our work if possible, to have a press made in all haste by a carpenter, of a style like the book-printers' press, wherein the force is applied instantly from above.

As everything was very rough, the new press was ready in eight days. The first experiment, with a small stone, seemed to succeed. But the larger stones would not give thorough impressions, probably because of the uneven surface of the press, which was merely of wood. I increased the power enormously. A stone of three hundredweight was elevated with pulleys and released suddenly to fall ten feet. It forced a lever down on the press with a pressure of more than ten thousand pounds. The plates gave fair impressions by this means, but generally they were cracked after the first, second, or third impression.

To determine how much downward force was needed to print a sheet of music, I took a well-ground stone a square inch in area, laid moistened paper on an inked printing-stone, over this a sixfold layer of paper, then a double layer of fine cloth, finally the square inch of stone, and then weights ranging from one to three hundredweight.

This experience taught me that the square inch of surface demanded three hundredweights of force to make a good impression in a few seconds, and almost less than half that weight when I allowed it to act for a whole minute. According to this calculation the entire sheet, which contained about one hundred square inches, would have demanded thirty thousand pounds; and the stone could have withstood this without cracking, had I been able to apply the pressure evenly. But the imperfections of the press made it necessary to apply a pressure three times as great, and this the stones could not bear.

To correct the defects of this press was more than I cared about, after I was nearly killed by the three hundredweights, which fell accidentally, and, as I stood immediately under it, would have beaten out my brains had not a miracle caused the load to catch and hold. The thought that a similar accident might cause the death of one of my men made me hate the whole press, all the more so as I had conceived what seemed to me at the

time an exceedingly happy idea for a very simple and not costly printing-machine.

Before I possessed a press of my own, I used to pull proofs of my work in the following manner, in order to avoid the constant trips to a printer. I laid the dampened paper on the inked stone. Over it I laid some heavy paper, and then a sheet of stiff, carefully smoothed dry paper. Then I took a piece of polished wood and rubbed this over the upper sheet of paper, holding the latter firmly to prevent slipping. I continued the rubbing, using more or less power according to whether I wanted the impressions deep or pale. Thus I obtained impressions very often that could not have been better.

I wondered why this could not be done on a large scale, and proceeded to try at once. I stretched a piece of linen firmly over a wooden frame two feet long and wide. On this linen I pasted a sheet of strong paper, polished on the upper side with wax. Then with two bands the frame was fastened to an ordinary wooden table. Then the stone was fastened on the table under the frame. Inside of the printing-frame was a smaller frame with cords, to hold the paper, which had a layer of gray blotting-paper under it. With a piece of polished wood, or a piece of glass such as is used by polishers, I rubbed the upper waxed paper thoroughly, making sure that every spot was touched.

The first proof, and several succeeding ones, which I made myself, turned out so excellent that probably few better impressions ever have been made since. Two more presses were made at once, and six printers hired. The work might still be finished in the stipulated time. New hopes thrilled us. Hastily I inscribed the stones and the printing began. But — oh, human weakness! Does it seem credible that of my six helpers not one could master the extremely simple method of manipulation, the mere matter of rubbing evenly and thoroughly? Of six impressions hardly one ever reached perfection. There were blank spaces here and there. Yes, even when, accidentally, they produced three sections of a sheet correctly, the fourth invariably was a flat failure, and thus ruined the entire sheet. We would have been glad enough had we lost even one half the paper, if

only we could have saved our credit by completing the work, regardless of our money loss. But of three reams of paper only thirty-three impressions were won in the end.

I will merely touch on the painful scenes that ensued. The stipulated time had almost expired and no prospect of results. The manuscript and the paper remaining in stock were taken away from us and given to Herr Falter, while we had to suffer severe censure from the Countess, and in her name from others. Herr Gleissner had to pay for new paper, which made a monthly deduction from his salary necessary. The grant of our privilege was endangered, for the Kurfürst had obtained a poor opinion of our process. Indeed, so long as the Kurfürst Karl Theodor lived, all our efforts to obtain a privilege were fruitless. We could not even succeed in having it proposed, although the referee, Herr von Stubenrauch, made us promises from month to month.

All the money we had earned was lost; debts burdened us; and a monthly deduction of pay, with the mocking laughter of those who had been made envious by our first successes, was the entire reward for our endeavors to make a new art. As it was only the lack of a good press that had caused our failure, I went to Herr Falter, with whom I had become acquainted through Herr Gleissner, and told him the reasons for not finishing the cantata in time. I told him that if he were willing to have a proper press built, I was willing to print his works for him, in his own residence, which was his stipulation, provided I could prepare the stones at home. We agreed, and I ordered a great cylinder press made at his expense. To avoid the old trouble I had both cylinders fitted with cogs, which gave satisfactory results if both printers who handled the press were careful to begin turning the cylinders at the same moment. The double friction of the two rollers made them both pull on the printing-frame and the stone, where, before, the lower cylinder had done just the opposite. The greater periphery of the upper cylinder, which was almost fifteen inches thick, helped also. And to this day I consider this form of press the best for all methods, especially if the stones are thick enough, if one has not to consider the very greatest speed; for in speed this press is decidedly

inferior to the lever press and other styles. On the other hand, the pressure is much more gentle, more perpendicular, and less liable to pull the paper out of place than is possible with even the best so-called friction presses. Only there should be added to the cogs an appliance by which the upper cylinder has a screw adjusted over its centre, so that it can be forced down for each impression after the stone is under it. Figure 1, plate 1, is the picture of such a cylinder press, made for stone-printing.

As soon as the press was ready and erected, I began to inscribe on stone the music of *Die Zauberflöte*, arranged for quartette by Herr Danzy, and with Herr Gleissner we began the printing.

But Herr Gleissner became dangerously ill. I trained two soldiers to do the printing, left the entire printing process to Herr Falter, and limited myself to the work of delivering the stones to him. The workers ruined so much paper that Herr Falter could not make it pay, and returned to etching on copper.

During this time Herr Schmidt, professor at the military academy, had begun to etch on stone. As I discovered long afterwards, he was a good acquaintance of Herr Gleissner, who visited him often. Within the last year there is a strenuous attempt to make this Herr Schmidt appear to be the inventor of printing from stone, though probably he never desired this. There have been publications about it already. I shall not notice what has been said, and will let the matter speak for itself. From the foregoing the reader will have seen the natural but laborious way in which fate led me to this invention. If Herr Schmidt made a similar discovery at that time, he was much more fortunate than I. According to his own letter, printed in the *Anzeiger für Kunst und Gewerbfleiss*, the course of his invention was as follows. He saw a gravestone in the Frauen-Kirche, in Munich, on which letters and pictures were in relief. "That must have been done with acid; it would be possible to print from it!" thought he, and the invention was completed.

If it is so easy to gain the honor of an invention, then, indeed, I was unlucky to have undergone so much toil. But according to my opinion, there was nothing new in the whole discovery. The thought that "this

was etched" assumed the invention and the use of etching beforehand. That such coarse, thick, and highly relieved inscriptions as those on grave-stones could be inked and used for printing would strike anybody who knew even a little of printing. If, however, Herr Schmidt added to his idea the second, that fine and, therefore, only slightly elevated inscriptions and illustrations could be inked and printed with the aid of appliances to be invented for the purpose, — if he did this and executed it before me, or, at least, before he had knowledge of my work, then indeed the honor belongs to him of having invented mechanical printing from stone, either before me or simultaneously. But as a matter of fact, neither he nor I can claim to be the first who thought of using stones for printing. Only the "how?" is the new thing in the case.

At that time (1796) I had not invented stone-printing, but, firstly, an ink available for writing on stone and resistant to acid, which ink I invented out of my brains and not, like Herr Schmidt, out of an old Nürnberg book: secondly, I invented a practical tool for inking the slightly elevated letters: and thirdly, the so-called gallows or lever press, of which I shall speak later.

As I do not know what were the circumstances surrounding Herr Schmidt at the time, and I cannot, therefore, make any inquiries, I am willing to take his word if he will declare as an honest man that he printed from stone before July, 1796. That his method of printing was different from mine, and that he had absolutely not the slightest knowledge of chemical printing from stone, which I invented in 1798, I know from indubitable evidence.

He made many attempts with his pupils to produce drawings on stones, but presumably his impressions were not successful, for those stones that I saw afterward at Herr Schulrath Steiner's had been etched first and the spaces then engraved away very deeply with all sorts of steel instruments, after the manner of wood-cuts, so that they might properly be called stone-cuts in relief. He had these stones printed in the Schul-fond's book-printery, and I hear that the impressions were very good. I saw none myself.

However, Professor Schmidt's experiments were the means of making me acquainted with Herr Schulrath Steiner, who encouraged me so much that I conceived many ideas in order to fulfill his wishes, so that at last the art of printing from stone achieved its present honorable position.

Herr Schulrath Steiner, an intimate friend of Professor Schmidt, was director of the Schul-fond's printery. As such he was concerned with many prints. Herr Schmidt's idea of publishing stone-etched pictures of poisonous plants for school use was approved by him; and as the attempts did not satisfy him, he decided to turn to me. At that time the Schul-fond was to print some church songs. This gave him the opportunity of visiting me. He asked me if the musical notes could not be so etched or cut in relief in stone that they could be made up with ordinary book-types and thus printed in the ordinary book-presses. I promised to try it. However, the necessary deep engraving of the spaces was too laborious, so that it would have been easier to do it in wood. As an expedient we printed the text first with ordinary types in the book-press and then printed in the music with stones in the stone-press.

Meantime I tried to attain our purpose in other ways, connected with some of my early experiments. My best success was with the following method. On a stone polished with sand I painted a layer, equal to two or three card-thicknesses, of burned, finely powdered gypsum, butter, and alum, mixed with a proper amount of water. As soon as it was dry I inscribed the music with steel needles of various sizes on the surface of the stone, which was of a somewhat dark, almost gray color, so that I could see it more easily through the soft, white mass. Having finished the drawing I took warm sealing-wax smeared on wood, and applied it to the stone while it was warm with a hand-press. After cooling, the white mass was fast to the sealing-wax and quite loose from the stone, and it was scrubbed away clean with water and a brush, after which the drawing appeared on the wood in elevated wax extremely clear and clean, like a wood-cut. The spaces were so deep that the plate could be printed in regular book-printing manner.

Later I made trial of a composition of lead, zinc, and bismuth, and this

succeeds thoroughly with proper care. So here we would have still another printing process, which has the advantage over all others that the inscription need not be made reversed, as the impression on the wax or lead reverses it automatically.

If the white mass is laid on more thickly, one can make the handsomest patterns for calico much more quickly than has been possible heretofore with wood-cuts. A little more care is necessary, because no stroke must be made entirely through the mass, when it is laid on thick. My experiments in that direction all exceeded expectations, and it is to be regretted that I had no opportunity thereafter to perfect this invention more, or use it practically. The experiments had no value even for Herr Schulrath Steiner, for whom I made them, as he never had use for the process afterward. Indeed, I would have forgotten the matter almost entirely, if it had not been brought back to mind by this work of writing my story. In the second part of this book, in describing stone-printing itself, I will show various methods of making patterns for work on cotton, such as I conceived later in Vienna where I busied myself very much with cotton-printing.

I happened to print for Herr Lentner a little song about the great fire of Neuötting in Bavaria and used a little vignette showing a burning house. This induced Herr Steiner to let me etch a few small pictures for a catechism. So far as execution of drawing goes, they were very ordinary; but he continued to encourage me to try if the new printing process would not be available for art work. With the exception of Herr Andre of Offenbach, he was the only one who reasoned thus: "These strokes and points, of such great fineness and again of such great strength, can evidently be made on the stone, therefore it is possible to make drawings similar to copper-plate etchings. That this cannot be done yet is due not to a fault in the art of stone-printing, but to the insufficient skill of the artists."

Even at that time he did not say: "The art is still in its infancy," as many a would-be wise man does to-day, thus exposing his lack of knowledge of the entire matter. Even at that time he was convinced, more so even than I, that the art of stone-printing had reached its climax when I

gave him the first specimens of stone-printing improved by the chemical process. Artists might cultivate and perfect themselves, manipulation be simplified and processes be increased in number and variety, but the art itself could not be improved greatly.

To be sure, when I glance hurriedly over the manifold results of the last twenty years, all that I have done myself for perfection, the brilliant achievements of which this book will furnish proof, I am tempted to think for a moment that the Now and the Then cannot be compared. But considered correctly, I had invented and discovered the entire art at that time. Everything that I and others have done since then are only improvements. Everything rests still on the same principle: ink of wax, soap, etc., then gum, aqua fortis or another acid of which none has an advantage over the others, further oil varnish and lampblack, — these are, ever and in the same manner, the chief elements of stone-printing as they were then. Not the slightest thing has been changed, improved, or invented in the fundamental principle. No illustration has been published by any lithographer containing cleaner, stronger, or blacker lines and points than my first proofs had in part.

Therefore, those people are wrong who seek to excuse the lack of assistance that I received in the beginning, by alleging that at the time no one knew if the process could be used to any great extent. They declare many productions of the present day to be far better, simply because the illustrator is more skillful, though in truth the printing is not so good as many of the first ones made by me. It has even happened that the assertion has found its way into print that I had invented only the rough part of the art, and never had been able to use it for more than music-printing, whereas this one or that one are the true artists, having succeeded in producing pictures.

These gentlemen, who are so quick with verdicts, should inform themselves a little. They would discover that aside from me (with the exception of Professor Mitterer's invention of the cylinder press), nobody has made a noteworthy improvement in the branches of lithography without having received it primarily or indirectly through me. Further they would have

learned that these illustrators either made their first attempts under my personal direction, or else owe their skill to persons whom I taught; and lastly, that none of my critics can boast of having penetrated into the very inmost spirit of the art like only Herr Rapp of Munich, the venerable author of the work published by Cotta, *The Secret of Lithography*. If they learned all this, they might feel a little ashamed. But then, they would have much to do.

Had my skill in writing and drawing on stone been greater at that time, Herr Steiner would have given me opportunity enough and manifold. He permitted me to do a small book, *Rules for Girls*, in German script, which, on the whole, turned out of only average quality, as I had not practiced this style sufficiently.

Then he wanted me to draw Biblical pictures on stone or to let others draw them. At that time he was having Herr Schön in Augsburg etch the Seven Holy Sacraments after Poussin. As the etching was expensive, the impressions could not be sold for less than four kreuzer each. Herr Steiner wished to circulate these pictures so generally that they could serve as gifts from the country preachers to their little Christian pupils. He wished, also, to ornament various school-books with pictures of this kind, and thus, gradually, to replace the miserably drawn species of saints that generally fill the prayer-books of the pious households.

Only the utmost cheapness could make this possible, and this naturally suggested the stone process to him. Even if the pictures were not so fine as those etched on copper, they would serve amply if they were correctly drawn, noble in design, and handsomely printed. It was necessary either to draw myself and practice faithfully, or to train a skilled artist to draw with fatty ink on stone. We preferred the latter method and trained several young men, who produced various works, sometimes good, sometimes inferior.

Through all this I ran more and more danger of losing my secret. Indeed, it was lost already except perhaps so far as concerned the exact composition of the ink. But I hoped still to obtain the privilege for Bavaria, toward which end the Schulrath promised me his best aid, and so I let the

matter proceed, and trained the men. But among all these young men there was not one who did not desire a substantial reward for his very first attempts, and when they found that they were expected first to learn, they stayed away, one by one. Herr Steiner was hurt. I, however, was indifferent, for I was just beginning to plan to use a new and important discovery in such a manner that my stone-printing would be greatly improved and we could hope to carry out our idea of illustrations without the aid of artists.

I had been assigned to write a prayer-book on stone for the Schul-fond. It was mostly in a style of writing in which I was least expert. When I wrote music notes, our method, proved best by experience, had been to write the entire sheet in reverse on the stone with lead pencil to serve as pattern. This was mostly Herr Gleissner's work, and being a musician he had achieved great perfection. For me this preparatory work was far less agreeable than the final execution with the stone-ink. Therefore, as ever in my life, when a difficulty or a burden was before me, I studied for some way to make it easier for me. Previously I had found that if one wrote on paper with good English lead pencils, then moistened the paper, laid it on a polished stone and passed it through a powerful press, a good impression was the result. I had used the method on various occasions. I wished that I possessed an ink that could be used the same way. Trials showed that fine red chalk needed merely to be rubbed down gently in a solution of gum, and that even the ordinary writing-ink of nut gall and vitriol of iron would serve when mixed with a little sugar. But this did not satisfy my ambition, which always demanded the best and most perfect. The gum in one and the vitriol in the other did not agree well with the stone-ink. In addition, the impression often squashed. Therefore I tried a mixture in water of linseed oil, soap, and lampblack which met my demands better. I had a music-writer write notes correctly on note-paper with this ink, printed it on the stone, and thus had an accurate pattern, which was at the same time reversed, as was necessary.

I now planned to do this with the book. But why could I not invent an ink that would serve on the stone without making it necessary to trace over

it with the stone-ink? Why not make an ink that would leave the paper under pressure and transfer itself to the stone entirely? Could one give the paper itself some property so that it would let go of the ink under given conditions? So reflected I, and it seemed to me not impossible. At once I began to experiment. I had observed that the stone-ink at once began to congeal and stiffen when it came into contact with ordinary writing-ink, because of the action of the vitriol of iron, which devoured the alkali that the stone-ink needed to keep it in solution. Therefore I wrote with ordinary ink, into which I put still more vitriol of iron. After it was dry, I dipped the sheet into a weak solution in water of my stone-ink. After a few seconds I withdrew it and washed it very gently in rainwater. I found that the ink had fastened itself on the written places, and pretty thickly, too. I allowed the paper to dry slightly and transferred the writing to the stone. The impression was fair, but not sufficiently complete. I tried it repeatedly but could obtain no transfers that were sharp and uniform enough to represent a handsome script. So I tried another way. I painted the paper with gum solution in which vitriol of iron was dissolved. After it dried I wrote on it with my ordinary stone-ink and dried it again. Then I dampened the paper and let it lie a while to soften, after which I transferred it to the stone, which had been treated with strong oil varnish diluted in oil of turpentine, laid on so lightly that it was only like the blurring from a breath.

These attempts were far more successful, but it was impossible to write as delicately on this paper as I desired. Therefore I made new experiments. I changed the mixture of my ink. I tried to make it more adhesive with mixtures of resin, oil varnish, gum elastic, turpentine, mastic, and similar substances. In short, I do not exaggerate when I declare that this matter cost me several thousands of experiments. I was rewarded sufficiently by succeeding. And at the same time through these investigations I discovered the chemical printing on stone of to-day.

As the transfer from paper to stone depended mainly on the greater or lesser powers of adhesion between one material and another, it was natural that in my many experiments with such various ingredients I should

observe that a mucous fluid, as, for instance, the gum solution, resisted the adhesion of the greasy ink. Nearer still to the new invention did the following experiment bring me: I noticed that if there happened to be a few drops of oil in the water into which I dipped paper inscribed with my greasy stone-ink, the oil would distribute itself evenly over all parts of the writing, whereas the rest of the paper would take no oil, and especially so if it had been treated with gum solution or very thin starch paste. This fact led me to investigate the behavior of paper printed with common printing-ink.

A sheet of an old book was drawn through thin gum solution, then laid on a stone and touched carefully everywhere with a sponge that had been dipped into a thin oil color. The printed letters took the color well everywhere and the paper itself remained white. Now I laid another clean white sheet on this, put both through the press, and obtained a very good transfer, in reverse, of course. In this manner, if I used great care, I found I could make fifty and more transfers from the same sheet. If I allowed such a transfer to dry thoroughly and then treated it like the original sheet, why should it not produce transfers that are like the original, not reversed? So thought I, and the result showed that I had not been wrong! Only for the first transfer I needed to use a somewhat stiffer color that had been dried more with litharge of silver, and then to let the transfer dry for at least four or six days.

So I came to find that I could print without a stone, from the paper alone; and this process, depending solely on chemical action, was totally, fundamentally different from all other processes of printing.

Old books could be republished in this manner easily and without great cost. New ones also. I needed only to invent a fatty ink, similar to the printing-ink and drying thoroughly, and I could use every sheet of printed paper instead of type. I invented this ink soon. Resin, finely pulverized litharge of silver, lampblack, thick oil varnish, and potash properly diluted with water gave me a good ink for the purpose. The only obstacle that prevented me from using this process at once on a large scale was the fragility of the paper, which tore into pieces under the slightest careless-

ness in handling. The natural and simple thought that was bound to come to me under the circumstances was this, Could not a stronger material, perhaps the stone plate itself, be so prepared that it would take ink or color only on the parts covered with fatty ink, while the wet parts of the stone resisted it? I feared that the stone might not absorb the grease sufficiently, and this really is the case with many stones, such as slate, pebble, grindstone, glass, porcelain, etc.; but experiments showed that exactly the opposite is true in the case of the Solenhofer limestone. This stone has a great affinity for fat, which often is absorbed so deeply that in many cases even extensive grinding will not remove it.

I took a cleanly polished stone, inscribed it with a piece of soap, poured thin gum solution over it and passed over all with a sponge dipped in oil color. All the places marked with the fat became black at once, the rest remained white. I could make as many impressions as I pleased; simply wetting the stone after each impression and treating it again with the sponge produced the same result each time. The impressions became somewhat pale, because the color on the sponge was too thin; but I obtained perfectly black and handsome impressions as soon as I used an ink roller of leather stuffed with horse-hair.

I hurried to write a sheet of note music at once to print it in the new way; but the ink flowed too much on the polished stone. Previously I had corrected this by rubbing the stone with linseed oil or soap-water, which checked the trouble entirely. But I knew that I could not do that in this new method, because then the stone would have a coating of grease all over, and would take color on the entire surface. However, I was able to take this coating away after writing, by etching with aqua fortis, though etching would not have been necessary otherwise in this chemical form of printing. However, it was easy to see that a drawing etched into relief would be easier to print from than one not etched at all. It did not require much etching, and I saved a great deal of acid, while the stone, also, remained useful for new work for a much longer period. Therefore, without making further experiments, I adhered to my old method, first washing the stone lightly with soap-water, drying it well, writing on it with wax ink,

and then etching with acid before I finished it for printing by pouring gum solution over it.

At first I imagined that I might do without the gum entirely; but I found soon that it really formed a sort of chemical union with the stone, making its pores more receptive to the grease and closing them more effectively against water. I found also that neither aqua fortis nor gum was so valuable alone as when both were used in the process.

I needed to make only a few more experiments to obtain the proper consistency of ink, and the new process would be practically perfect so far as the fundamental principle was concerned. And, in fact, I made such handsome, clean, and strong impressions after three days of trial that few better ones have been made since. Now it was necessary merely to train skillful workmen and artists as quickly as possible for this new art, that was susceptible of innumerable valuable uses, as I could see at once.

It made no difference now whether the design was worked in relief or intaglio, as good impressions could be obtained even when the drawing was perfectly level with the surface of the stone. But all three methods could be combined on one stone, if desired. If I reversed the method, by rubbing oil over the stone instead of water, while for printing I used an ink prepared with gum solution (of which I will describe the best composition afterward), then the greasy places would resist color while the wet ones took it, and thus I could print with all water colors, and this is necessary sometimes with colored pictures because of the greater height of the colors. The inscription with dry soap gave me the logical idea toward crayon work, which I used afterward. My previous experiments with etching, that recurred to my memory, now assumed entirely different aspects and I could understand many things that had puzzled me then.

It was a simple step now to the etched method, in which the stone is prepared first with aqua fortis and gum, after which the design is engraved in intaglio without first being treated with aqua fortis. Indeed, this method was used for the first work that I undertook.

A piece of music by Herr Gleissner (which afterward was greatly praised in the musical paper) had been completed before I invented the

new process. Only the title-page remained to do. As I wished to make this as handsome as possible, since Herr Gleissner intended to dedicate the work to Count von Törring, I chose this new intaglio style, because I hoped to do my best work in it. Any one who still possesses a copy of this symphony can see by slight examination that the printing was done from an etched engraving. Therefore Herr Rapp in Stuttgart is mistaken when he assumes that he is the first who treated the stone in this manner. As early as the year 1800 I deposited in the archives of the Patent Office in London a full description of this and several other methods, some of which have not been used yet generally, and in 1803 I had to submit my descriptions to the Austrian Government when they gave me a franchise.

A year before this, I had invented the lever press, with which I could make several thousand of the handsomest impressions during a day. This, combined with the new treatment of the stone, enabled me to enlarge my operations greatly. I took in two of my brothers, Theobald and George, who had been in the theatre hitherto, and taught them to write and etch on stone. Also I took in two boy apprentices, sons of poor parents, to train them properly. Herr Schulrath Steiner and Herr Falter, with several others, gave me various orders, and a pretty good outlook began to appear for me and Herr Gleissner.

Until now we had been forced to suffer much grief, disappointment, deprivation, and poverty. Herr Gleissner's salary was only three hundred gulden a year. A yearly deduction of one hundred gulden was being made from this by the Government to pay debts. Then there were new expenses to repair the printery and keep it in some sort of order. My support and that of the family Gleissner, —which consisted of five persons, —then a larger residence, on account of the room needed for stones and for printing, also had to be paid for. My own yearly earnings were barely a few hundred gulden, as most of my time was used for experiments. It is no wonder, then, that during this sad period of two years, we spent almost all that could be spent of Herr Gleissner's estate, and still made new debts, despite all imaginable economies.

I can say for the honor of this man, and especially his wife, that, despite

all their losses and despite the warnings and inciting of their friends and relatives, they remained unshaken, and by making all kinds of sacrifices they enabled me to win at last. On my part they saw faithful and eager will, and a restless endeavor that went so far that I hardly took any time for eating or sleeping, but thought only of improving my art.

Now, however, our condition was changed at once. Many days we earned as much as ten to twelve gulden; and at the same time we received an exclusive franchise for fifteen years through the favor of King Maximilian Joseph, who began his glorious reign then. This privilege gave us the right to print and sell exclusively in all of Bavaria, while infringers were liable to a fine of one hundred gulden and confiscation of all stock and apparatus.

We were determined to do our utmost, to work day and night, to establish an honorable reputation for our printery at last, though we foresaw many obstacles, owing to the entire lack of assistance. Already I had half-determined to contract with the Schul-fond, permitting it to establish a lithographic press for its own use, when an accidental circumstance gave our whole undertaking a new direction.

Depending on the protection given to us by our franchise, we were making no further secret of any part of our process. We were quite content with having the monopoly in Bavaria, and cared little that other printeries might arise in other countries. Indeed, this expectation flattered my vanity as inventor, and I thought that in time I might make commercial connections with such establishments. For this reason I was very hospitable toward every stranger who came to visit us. I hoped that perhaps I might induce some such visitor to participate in our undertaking, and therefore I exhibited all the advantages of the process and permitted them to see the manipulations with their own eyes.

Just then Herr Andre of Offenbach visited Munich on business. He read about the grant of our franchise and asked his friend Falter about the process. That gentleman showed him some sheets of music printed by us and offered to introduce him to our printery, where, as technical expert, he could decide for himself as to the value or worthlessness of the new art.

Herr Andre, who possessed an extensive musical publishing institution and owned a large zinc-plate printing-plant, was delighted with the beauty of our print, and was especially impressed by the fact that the color did not off-set when rubbed with the hand, as was the case with zinc printing. He accepted Herr Falter's offer at once and was introduced as a merchant. The attention with which he noted even the slightest operations led me to conclude at once that this man had some especial interest in printing. I took particular pains to display the whole process to the best advantage.

Several plates that were already inscribed were etched and printed with beautiful results. The speed (seventy-five sheets in a quarter-hour, two being printed simultaneously each time), the quickness of drying, the economy in color, were things that increased his interest to a high pitch. He told who he was and proposed to me that I teach him the entire art for an adequate remuneration. I accepted at once and agreed to go to Offenbach within a few months, erect a press, and train men in all branches of the process. For this he promised me the sum of two thousand gulden, of which he paid down three hundred gulden on the spot.

This change from poverty to comfort made me happy mainly on Herr Gleissner's account. We could furnish our printery properly now and pay our old debts. We were assured, also, of enough work to permit enlargement of the establishment in future. What was there left to wish?

In the very beginning, however, the behavior of my own family gave me great displeasure. My mother demanded that I share my profit with my brothers, as they had a better right than Herr Gleissner and his family. I could not quite see this; therefore my mother ordered a press for my brothers and bought the necessary stones. They went to Herr Falter and asked him for his work, representing that I had made my fortune through Herr Andre, whereas they were unprovided for. They offered at the same time to furnish each plate for thirty kreuzer less than I charged. Herr Falter permitted himself to be convinced, and when Madame Gleissner discovered it she was intensely angry, and did not rest till the Government

ordered my brothers to refrain from utilizing the process in Bavaria for their own account.

My brothers went to Augsburg to erect a stone-press for Herr Gombart. They must have been unequal to the attempt or there must have been other difficulties: in brief, I know only that, after Herr Gombart had incurred many useless expenses, he discarded printing from stone.

During the three months before my journey to Offenbach I practiced my art busily, and especially studied to attain thoroughness in one branch that was of importance to Herr Schulrath Steiner. I have spoken already of his idea for pictures for children. As soon as I had invented the new chemical printing, I thought of inking an etched copper plate with a composition of tallow, soap, lampblack, and oil varnish, making an impression, laying this on stone, and putting it through the press. The picture transferred itself to the stone as I had expected. Then I poured the water and gum solution over it and inked it with the ink roller. The design took the color well; and thus, if the stone was very clean in the beginning and the proof from the copper had been made very carefully indeed, I could print several thousands of copies which resembled the original so closely that only a slightly greater degree of sharpness, clearness, and strength gave the copper etching an advantage over the stone impressions. At last I succeeded in perfecting the process so that actually my best impressions from the stone were better than those that had been made with less care from the original copper plate.

The main requisite in this process was that the ink be firm enough not to spread in printing, and still so greasy and tender that the very finest lines would come out. The copper plate had to be washed with extraordinary care, for the least bit of grease that should off-set on the white paper would, of course, transfer itself to the stone and make that part take color.

This latter circumstance was intensely difficult to overcome. It occurred to me to treat the copper plate chemically, like the stone, so that its surface would resist the ink. I succeeded, as, in future, I succeeded with other metals. The fundamental principle in each case remained the same. Only

in the choice of materials for each metal was there a difference. I discovered soon that there are two kinds of preparations, one acid and one alkaline, for all solid bodies which have the property of taking and absorbing oil colors. The alkalines seemed to be best for use on copper plate, and I obtained such clean impressions that the stone did not take on even a vestige of ink in any spot except the design. At the same time I found that chemical printing does not limit itself to stone, but can be done on wood and metal, as well as on paper, as stated already. Yes, though apparently it is incredible — even fats, such as wax, shellac, resin, etc., can acquire the attribute, under certain circumstances, of resisting color, and, therefore, are available for chemical printing. This fact gave me hopes of discovering a sort of artificial stone some day, which might be less costly, less massive, and less fragile; and, as a matter of fact, I succeeded in inventing an artificial stone-paper in 1813, a stony mass that is smeared on paper or linen and looks somewhat like parchment.

Since the illustrations on etched copper plates were so readily transferable to the stone, Herr Schulrath Steiner could now let the best masters etch his pictures. The sales of the original impressions as works of art always covered the costs. He paid me five gulden for each transfer that I made from the copper to stone. For this extremely small sum he obtained a stone plate from which there could be made countless impressions, which, although not so fine as those from the copper, answered his purpose of circulating good pictures by making them extremely cheap. Lively prosecution of this process was prevented only by the delays of copper etchers, so that we were able to utilize it only five times on a large scale before I had to leave Munich.

Herr Gleissner, who wished to visit a friend in Frankfurt, accompanied me on my way to Offenbach. I started at once on the new work and within fourteen days I pulled the first proof on Herr Andre's own press. He was so well satisfied, and, besides, had so thoroughly considered the advantages of stone-printing, that he proposed to me to leave Munich entirely and, with him as associate, extend the art in the best possible way. He had three brothers, none of whom was engaged in a fixed occupation. He

intended to bring these into the partnership. Two were in London, the youngest and the eldest. The latter was to return soon. One brother had lived long in Paris, and was well acquainted with that city as well as with French affairs. So he laid out the following plan. We would try to obtain exclusive franchises in Paris, London, Berlin, and Vienna. Then a stone-printery and art publication house was to be opened in each city. His brothers should manage affairs, one each in London, Paris, and Berlin, while I was to take the management in Vienna. Offenbach and Frankfurt would remain under Herr Andre's management and be the centre of control and union.

The plan seemed to be easy to realize, as there was no lack of means. I could look for one fifth of the profits which would be earned by the combined, very considerable capital of the Andre family. In addition, Herr Andre possessed all the requisite knowledge and owned a great business already. Therefore I agreed gladly, after making the condition that Herr Gleissner was to remain a partner of mine and receive a decent remuneration till the business was in working order.

Herr Andre was well content, for Herr Gleissner could be used as compositor, corrector, and writer in the business, which was to consist largely of music publication in the beginning.

Herr Gleissner and I returned to Munich to arrange our affairs there. He intended to ask for three years' leave of absence. I planned, in order to save Herr Steiner any embarrassment, and also to maintain our privilege in Bavaria, since one could not tell how the Andre undertaking might turn out, to so arrange that our work could be printed properly during our absence, whether done by the Schul-fond, the Government, or private persons. It gratified me also to have an opportunity to satisfy my mother's wishes in regard to my brothers; and I gave my brothers, Theobald and George, my press, my stones, and everything else that was on hand, also the two trained apprentices, and only stipulated for myself that I should have one fourth of the net profits, leaving the accounting entirely to their sense of honor. They promised to keep accurate books and work steadily and economically, and they received from me minute instructions about

transferring from the copper for Herr Steiner. I taught them also how to handle the crayon process, which promised an early harvest.

As soon as all was done I went to Offenbach with the whole Gleissner family. A good quantity of stones had arrived there, and a few men, previously trained, had been practicing in transcribing music. We were able to begin on a large scale at once. Herr Andre had ten copper- and zinc-plate presses at work. He stopped five and used the workmen for stone-printing. He went to London, partly for business, partly to get his youngest brother and to inform himself thoroughly about the procedure necessary to obtain English patents.

One of our chief speculations in England was to be the application of stone-printing to cotton. Once, when Herr Steiner conceived the idea of illuminating pictures with stencils in the way used by card-makers, I had made many experiments in that line. I cut out the parts to be colored in oil-soaked paper, laid this on the picture, and passed a roller over it with the desired color. The color was more even than with a brush, but not everything could be cut out, because the stencils had to have the necessary connection. Therefore I needed two stencils for every color shade. Again, these thin stencils easily slipped out of place, a defect that displeased me. Now, it happened that at times when I was a little careless, the whole stencil would roll itself up on the ink-roller. I found that it was possible to work even more surely when this happened, provided one found the exact beginning of the stencil and applied it minutely. But it was not possible to make more than twelve impressions. Then the stencil had to be taken from the roller that the latter might be inked again.

In this work the stencil paper often tore. To overcome this there was only one remedy, which was to make the roller hollow and feed it with color from inside. I did not have the time to try this and worked out another plan. I cut out the places to be colored in felt or leather, applied paste to their obverse sides, laid them face down on the exact parts of the picture which were to be colored, rolled a perfectly round roller over them, and the pieces adhered to the roller in their right places. Then the roller was inked with the required color, and of course took it only in the elevated

parts. At both ends the roller had a strip of leather of the same thickness as the cut-outs, thus making it certain that it would not touch the ink except in the proper places. In this way pictures could be illuminated very quickly, and several shades of color could be obtained if the pieces were of different qualities of leather, or of leather, cloth, and cotton, according to the shades desired. A very moderate pressure sufficed for good and even work.

What could be more natural than that I should deduce that this sort of printing might be utilized for cotton? Once inked, the roller was good for ten to twelve impressions, if the operator merely used a little more pressure as he proceeded. I saw also that the roller could easily be colored by attaching another to revolve with it and convey the ink. That would give us a form of cotton-printing that would proceed automatically.

The idea was too important to be left untried. I took a little roller, two inches in diameter and six inches long. I glued a piece of calfskin completely around it and then cut a design into it. Then this roller was so adjusted with relation to another of exactly the same dimensions that both touched perfectly. On this second one, which was to convey the color to the other, there rested a little box without a bottom, so that the roller itself represented the bottom as soon as the box was pressed on it, which was most easily done with two screws. The color was poured into this box. Now when the lower roller was passed over linen or cotton which was stretched on an evenly planed board with an under layer of cloth, a continuous print was obtained, without off-set, and with such celerity that it could be reckoned easily that with this process several thousand yards a day could be produced.

When I invented the chemical printing afterward, I held that a stone roller could be used for this work as well as a wooden one. I had too little knowledge of the industry at that time and believed that cotton print was done with oil-colors; for I thought that water-colors would wash out. I was a complete stranger to this work. Therefore, I drew a pretty cotton pattern on a stone plate and printed from it with oil varnish and finely pulverized indigo. The impressions turned out very handsome, so that I con-

sidered the matter settled and made no further experiments. I imparted this idea to Herr Andre, who saw its importance at once and determined to obtain a patent for it specially.

However, we had much to learn. As soon as he arrived in England he discovered that rollers with the design on them were in general use in England. So I had imagined mistakenly that my invention was new. However, printing from stone was in itself valuable for a patent, but Herr Andre unfortunately received the incorrect information that the inventor himself must appear in England, and he decided to send me there. I did not care to go; firstly, because I was vexed at the failure of my hopes in regard to cotton-printing; and secondly, because I wished to go to Vienna. However, I yielded to his representations, and within a few weeks journeyed to London with one of his brothers who spoke English.

We went through Hamburg to Cuxhafen and thence in an English packet-boat to Yarmouth, where we landed after a six days' stormy passage.

My sojourn in London did not achieve its purpose, which was to establish printing from stone. The exaggerated caution and precision of Herr Philip Andre, who had been named as the man who was to manage the London negotiations, caused a waste of seven months, during which nothing was done to reach our object.

We lived with Herr Philip and he kept me at home most of the time, for fear that I might betray our purpose, in which case some speculative spirit might take out a patent before us and then compel us to buy him off for some heavy sum. He did not reflect that a mere declaration is not sufficient in England, but that an exact description of a process must be deposited with the Patent Office.

As he could have rendered all these fears unnecessary by simply taking out the patent, I could not understand why he delayed from month to month, and at last I voiced my suspicion that he was not honest with me and had some unknown designs. I declared that nothing would keep me longer in England, which had become wearisome to me owing to my constant seclusion; and my suspicions were increased by the entire lack of all

news from the Gleissners and from my family. When Herr Philip Andre realized that I could be held back no longer, he went to work at last, and in twelve days we had the patent in our hands. As I had trained Herr Philip already in the art of stone-work, there was nothing to keep me longer, and I began my homeward voyage at once with my former companion, Herr Friedrich Andre.

My seven months' sojourn in London had the following results for myself and for lithography: —

First, I had decided in Offenbach to use my spare time entirely for the study of chemistry. Particularly did I want to learn everything that was known about color, that I might use stone for cotton-printing. I bought the best books and worked steadily, testing the teachings by experiment.

Second, I made many experiments with stone-ink, to find the very best composition. The ingredients which I utilized in course of the time were about as follows: —

Soap — *a*, common tallow soaps; *b*, Venetian soap.
B, wax.
C, tallow, butter, and other animal fats.
D, spermaceti.
E, shellac.
F, resins and Venetian turpentine.
G, gum elastic.
H, linseed oil.
I, the fat contained in chocolate.
L, various resinous products, such as mastic, copal, dragon's blood, gum elemi, quajac pensoe, etc.

Then I used various solvents besides the soap, such as —

M, vegetable alkalies, among them tartaric acid.
N, similar mineral alkalies.
O, animal lyes, spirits of sal ammoniac, and sal volatile with spirits of ammonia.
P, borax.
Q, various metallic solutions.

It is evident that with these substances an endless number of experiments can be made, not to count the variety of proportions. Certainly it is not exaggeration when I say that during that time and later I made many thousands of experiments, only to confirm my experience that accidentally I had discovered the best compositions during the first twenty or thirty investigations, and that my time after that had been wasted, unless I counted the knowledge I had gained of chemistry.

Thirdly, I made my first attempts at that time in the aqua-tint style, and also practiced printing with several plates, which I had begun previously under suggestion of Herr Steiner. The son of the Swiss idyllic poet, Gessner, was in London at that time and was a good friend of Herr Philip. He made some neat sketches for us in the crayon process, which I had invented in Munich immediately after my invention of chemical printing. I had exhibited the process to Professor Mitterer at that time, and he thought that it might become valuable for art.

Thus my residence in London was not unimportant for lithography. The complete lack of disturbance, the adequacy of all needed material, enabled me to discover more than I might have learned in Offenbach. I left England with a certain satisfaction, gained from the certainty that I had raised my art to a high degree of perfection.

I am satisfied even to this day that the world would have many masterpieces as the result, had I come into contact at that time with an enterprising art publisher who would have engaged the needed artists and undertaken interesting works. As it was, however, and as I shall show, circumstances forced me into untoward positions, so that little or no opportunity was left me to use my knowledge practically and in an important way.

Immediately on my arrival in Offenbach, I received the displeasing news that Herr Andre had sent Madame Gleissner to Vienna to claim the exclusive franchise for the new printing process, and to enter lawsuit against my mother, who had gone to Vienna with the same purpose.

The reason for this was as follows: My two brothers, Theobald and George, who could not earn enough in Munich, had been engaged as litho-

graphers by Herr Andre in Offenbach on my request. In a confidential mood I told them that I hoped to go to Vienna and open a great printing establishment and art publication house with assistance of Herr Andre, and that this establishment should make my fortune as well as that of my family.

Probably they did not believe my promise, or they did not care to depend on my fraternal feeling for something which they believed they could get for themselves: enough, they wrote to my mother that it was unfair to let Herr Andre become exclusive proprietor of the new process everywhere, and as I was well established in London anyway, she would better travel to Vienna and ask for a franchise. They sent her several good proofs from the Andre press.

Would to Heaven this plan of theirs had succeeded! I should have been spared many a succeeding sorrow, and I would have been glad for their sakes. The world was large enough for me, and certainly it was not thoroughly fair that they, the nearest relatives of the inventor, should be shut out by the far-reaching plans of Herr Andre to obtain exclusive franchises everywhere. To be sure, I had told them that I would give them the Bavarian franchise; but as they had enjoyed it for several months with little profit, this did not seem to them a tempting equivalent.

The news of my mother's journey to Vienna had been brought to Madame Gleissner quite accidentally, and it made her almost frantic.

When she used to charge me with depending so completely on Herr Andre's promises, without possessing anything in writing, I used to comfort her by pointing out his righteous character, and also by reminding her that it was all agreed that I and Herr Gleissner should undertake the printery in Vienna as part of the general enterprise, and that we were to obtain the necessary advance funds as soon as I returned from England. The repeated complaints that she made, many of them in the presence of my brothers, possibly helped to give them the idea of trying themselves for a franchise in Austria. They may have thought, "If our brother is careless enough to depend on empty words, we will be wise enough to obtain a certainty. It remains open to us always to share our fortune with the inventor."

Madame Gleissner had entertained great hopes about living in splendid Vienna and having means enough to take part in its brilliant life. This made the news about my mother's errand all the more irritating. She did not consider that an Imperial franchise is not easily obtained by women who are not even well informed on the case at issue. She succeeded in imparting her fears to Herr Andre, and as he himself was prevented from going, he entered into her fool's counsel to send her to Vienna at once. She had strong hopes of success, because as a matter of fact the Bavarian franchise had been obtained entirely through her efforts, and she also calculated that the Austrian Government would pay more heed to the inventor himself than to his brothers, who could not equal his attainments.

Herr Andre had kept it all, even to the journey of Madame Gleissner, a secret from me, presumably because he wanted to save me annoyance and also to prevent my hasty return from England.

Unfortunately I had conceived some suspicions in England, and these were increased when I received this unexpected news on my arrival in Offenbach. What was worse, Herr Gleissner gave me a letter from his wife, in which she adjured me to hurry to Vienna with all speed, as Andre was planning to deceive me and set me aside as a mere tool as soon as I had founded his own fortune.

This letter, which contained no evidence but only lamentations, was accompanied by another from her landlord in Vienna, a very reputable merchant. It seemed to bear her out, for he warned me in it to be cautious in my relations with Andre and to hurry to Vienna if I wished to obtain the franchise, which could not escape me as a most influential man had come to our support and it depended merely on the evidence to be furnished by me.

Greatly as my suspicions were increased by this, I hoped that everything was due merely to misunderstanding, and I proposed to Herr Andre to let me go to Vienna, where I would inform myself thoroughly and make strong efforts to obtain the franchise. He denied my request, saying that there was nothing more to do in Vienna, as the Government had turned both women away, and the whole plan was spoiled as the whole art and

copper-etching trade had become apprehensive and was united in opposition to the new process. He said that I should rather go quickly to work to transfer his music from zinc plates to the stone, because he had an excellent opportunity to sell his entire stock of zincs, which would give us a new capital of forty thousand gulden for the greater enterprises.

I realized the good sense of this, but would not admit that a delay of three or four weeks could interfere with it, as the entire transfers could not be completed in less than a year, and the slight delay, therefore, could be made up by additional work or by engaging a few more assistants. I insisted on my demand, all the more as I had spent seven months in England on his account. In the heat of the succeeding dispute he reminded me of the helpless position in which he had found me, and said that as partner in his business, I owed him all my present fortune. Conscious as I was of my honest intention to help him to the best of my ability, and also of the unbounded trustfulness with which I had imparted to him far more than was called for in our contract, I was so deeply hurt that I forgot myself and tore up our agreement, which had been signed only the day before and which assured for me one fifth of all profits of the Andre business. I threw the pieces down with the exclamation that I did not wish to make my fortune through his means.

This was one of the most important moments in my life, and in the process of lithography. It gave my work an entirely new direction, hurled me into a mass of troubles, and brought it about that Herr Andre himself did not gain anything like the expected profits from the new art. Indeed, he lost heavily in London and France, whereas, had we remained together, lithography might now be highly perfected in both these countries and produce no small wealth for its users.

When Andre saw that I was determined to go to Vienna, he yielded, but assured me that I would go in vain and achieve no result.

The lawsuit between Madame Gleissner and my mother, which Herr Andre considered the greatest obstacle in his way, still continued; and in order to get it out of the way once and for all, I took my brothers, George and Theobald, who had been dismissed by Herr Andre, to Vienna with me

to combine with me. Andre told me afterward, after our relations had reached final rupture, that this act had annoyed him most, and that it was the main reason for giving up all dealings with me, because it was inconceivable to him how any one, without the utmost weakness of character, could forgive such treachery as theirs. He did not reflect that I, who knew selfishness only by name, had not felt their affront so keenly, and that my brotherly affection excused it and made me trust that it never had been their intention to shut me out entirely from any gains they might make.

PART II

FROM 1800 TO 1806

IT was in August, 1800, that I went to Vienna with my brothers. In Regensburg we met my mother, who had come to visit one of her daughters because the decision of the Imperial Austrian Government had been delayed too long for her patience. She assured me that when she petitioned for the privilege she had named not only my brothers but me, too, and had asked it for us three.

This assurance gave me great joy, and I determined absolutely to urge Madame Gleissner to accept my brothers as partners. I thought that if we three worked industriously and unitedly, we would succeed much better and more quickly. I entered Vienna with excellent hopes, based mostly on a letter from Madame Gleissner, saying that the influential man who was interested in our cause had promised to advance us six thousand gulden. But these fine things retired into dark shadows when I learned, in my first conversation with her, that all these promises were made dependent on conditions.

The whole understanding rested on the following: Madame Gleissner lodged with a prominent family. Andre himself had told her that she was to live well and exhibit no lack of money, because she was much more likely to obtain the franchise if the Government were led to expect that it would bring wealthy people into the country. Therefore Madame Gleissner considered it necessary to take part in all amusements and fashions of her hosts. Her monthly expenditures were beyond the sum considered necessary by Herr Andre's friend in Vienna, who had been authorized to pay her an allowance. Friendly solicitude caused him to write to Offenbach that Madame Gleissner knew nothing of economy, and that it was to be feared if the franchise were not granted in Herr Andre's name, he would

have too little power to check her extravagance in the future. He added that judging from her utterances and her present behavior, with the franchise still in question, it was only too likely that she intended to spend Herr Andre's money for show and society instead of for the business.

Therefore, he advised that, unless Andre was sure that Senefelder had enough character to oppose her with the necessary firmness, we be treated solely as subordinates and thus be prevented from using his credit to his loss.

Well meant as this counsel was, it simply furnishes an addition to the thousands of cases where exaggerated timidity, coupled with secrecy, does more harm than good.

Andre knew my intense gratitude to Herr Gleissner and his family, and he suspected that I would always live in a certain dependence on them and would pay little attention to their financial doings. The Gleissners had awakened a fear of their extravagance in him before this time. He knew, for instance, that I had kept little of the money he had paid me for the secret of our process, but had turned almost all over to them. Again, he had granted us the sum of one thousand six hundred gulden for our support in Offenbach until the business should be in operation. Of this Herr Gleissner was to draw six hundred gulden and I one thousand gulden. I was a bachelor and did not need so much as a family. Therefore I reversed this, and gave Herr Gleissner one thousand gulden, keeping six hundred for myself. But the latter also went into the Gleissner treasury, because Herr Andre, who had come to like me very much, made me live in his house and eat with him. He even kept a horse for me, that I might have the exercise necessary for my health, and if he bought himself a new article of dress I was sure to get one like it; and I had to take part in all the amusements of his home, though many times I would rather have worked.

Thus I had absolutely no needs and did not require money. All the more did Madame Gleissner require. She strained everything to be very elegant and could not get along with the money she received, but asked for

further, quite considerable advances while I was in London, and Herr Andre granted these willingly through friendship for me.

Therefore Andre's suspicions seemed well founded; and as in his heart he was firmly determined to treat me as a brother, he believed that a mere outward formality and my hitherto quite unknown name would make no real difference, but rather that the Vienna undertaking would benefit if it had his own well-known name and excellent credit at its head in the very beginning.

So he wrote to his friend in Vienna that he agreed with him, and he gave authority to him to act as he thought best for the mutual good.

This gentleman told Madame Gleissner at once that Herr Andre had decided to ask for the franchise in his own name to give value to the undertaking, and that she was to appear before court and declare that she withdrew her petition and turned it over to him. She suspected a trick and refused. A dispute followed, and there came rebukes for her heavy expenditures. The climax was reached with the threat that, if she insisted on her refusal, Herr Andre would cease from that moment to let her have any money and would let her support herself.

This last, which Madame Gleissner wrote me in a very bitter letter, outraged me; for I held it cruel to send a woman to a strange city where she had no relatives or friends, and then to tell her: "Now do my will, or I will leave it to bitter necessity and your own helplessness to tame you." To be sure, it was only a threat, and surely it never lay in Herr Andre's mind. His friend never ceased to give her money. But the harm had been done.

Madame Gleissner appeared at her host's table with signs of tears that aroused the sympathy of her host, Herr von Bogner, a most worthy and reputable merchant. She told him everything, complained bitterly about my gullibility, and generally painted everything in such colors that Herr Bogner could not well help thinking that Herr Andre did not consider promises any too sincerely. It was only then that he learned Madame Gleissner's business and was told that the new art promised a great profit.

Herr Andre's far-reaching plans for foreign exploitation seemed to him

to confirm what she said. Herr Bogner thought that Herr Andre would not invest so much money if stone-print were not a valuable invention, and he asked Madame Gleissner, point-blank: "Why do you need Herr Andre at all? Try to obtain the Austrian franchise for yourself, and then, if you choose, you can take him into the company. Then he will be obligated to you and will have to meet your wishes, whereas now the reverse is the case."

Madame Gleissner interposed that Herr Andre had the capital necessary for establishing the process on a large scale, to which Herr Bogner responded that it was better to begin modestly. "A good thing," said he, "grows of itself. And you must not imagine that we here in Austria have no appreciation of useful inventions and undertakings. There are many who will assist the arts and industries. There is even a special fund from which as much as one thousand gulden may be advanced to develop an invention that has proved itself to be of merit. I myself might not be disinclined to become a partner after I have examined the matter properly; also I can recommend a very enterprising, active man, who has much weight with the Ministers and even with His Majesty the Emperor, and who has obtained exclusive franchises for others. He is named von Hartl, is Imperial Court Agent, and is a very sensible and honorable man, who will surely tell you at once whether or not anything can be done here with the process."

Herr von Bogner kept his promise, and introduced Madame Gleissner the very next day to Herr von Hartl. She explained our relations with Andre and described the new invention, wherein, to be sure, she did not fail to boast of its advantages and beauties. Among other specimens she produced a piece of cotton which I had printed in Offenbach.

This was very pretty, the print being so sharp and clear that it seemed to exceed the best English work. It happened that just then a great company with a capital of one and one half million gulden had been formed by Herr von Hartl to introduce English machine-spinning in Austria. They had secured a very skillful English mechanic named Thornton, who had been under contract to erect similar machines for a Hamburg merchant.

They had paid a great sum to have him released from this contract, had bought his machines, and had done enough sample work so that it had been resolved to push the enterprise through even if several more millions were needed. The chief objection that was urged at that time was that an adequate sale of the products was doubtful because of the widespread business that the English controlled. The reply was that they must seek to work up a great part of their product themselves, — that is, combine with their spinnery the industries of weaving, dyeing, and cotton-printing.

As soon as Herr von Hartl heard that the new invention promised great advantages for cotton-printing, he pledged himself to lay the matter before His Majesty at once, and he promised that if I would come to Vienna and produce the necessary proofs he would surely get the exclusive franchise for me. Furthermore, when Madame Gleissner told him, in reply to a question, that we would need about six thousand gulden in the beginning, he announced his readiness to furnish that sum himself if I could convince him that a real benefit was to be produced by the new art.

Madame Gleissner wrote to me, but withheld the condition of Herr von Hartl that I must convince him. I would have taken care not to give such greedy heed to her, for I knew from experience how difficult it is to convince most people. But, I was determined to show my friend Andre that I and my art were by no means at a loss without him. Besides, I always had the royal Bavarian franchise to fall back on. His secrecy had shaken my confidence, and I was determined to find out everything for myself.

Many years later, when I reviewed everything calmly, I was sufficiently convinced that Herr Andre always had meant honestly by me; and I count myself fortunate to have him still as my friend. But at that time various misunderstandings brought it about that he did not give me full knowledge of everything, before he took steps contrary to our agreement and without my cognizance that could not fail to impress me as strange, since I was ignorant of the circumstances. Besides, he defended himself against my accusations in a manner that affronted my vanity deeply, for he gave me to understand plainly that my past weakness in the matter of the Gleissners' extravagance proved that I should always have to dance to their tune. It

angered me that he should turn against me, as weakness, my recognition of the patient faithfulness of the Gleissners through the many sorrows that had overwhelmed us since the beginning of the process; and the more so as I was giving them merely that which I did not require and which was my own undisputed property. According to that, I would have earned the reputation of being a firm, strong man had I used my superfluous earnings to buy a few watches, a ring, or some garments, rather than to use it to pay a debt of gratitude! Besides, whatever Herr Andre had advanced to them was something that had been done without my knowledge; therefore I accounted all his charges as being only empty words, used to cover a proposed piece of trickery.

After my first conversation with Madame Gleissner, but more especially with Herr Andre's representative in Vienna, I realized that the latter could not be censured for his measures of prudence, and I repented that I had so easily given way to my quick sensitiveness. The *franchise* evidently was very uncertain. The only hope for it lay in the assistance of Herr von Hartl, and, therefore, depended on my ability to convince him. I had spent my money traveling, and instead of finding Madame Gleissner in funds, as I had assumed from her letter, I found her ill with only a few guldens, and in addition I had two brothers on my hands who also were penniless and looked to me for their support.

Madame Gleissner assured me that Herr von Hartl would assist us and that I could reckon also on help from her host, who had counseled her to part from Herr Andre and seek the privilege for herself. I mustered up sufficient courage to explain our situation to the latter gentleman and to ask him if we could count on his help for the beginning. This request must have been unexpected by Herr von Bogner, as Madame Gleissner's manner of living had indicated anything rather than lack of wealth. However, he liked my frankness, and promised active aid. He gave me a handsome room, and I and Madame Gleissner ate at his own table. He paid, also, for the lodging of my brothers in another house.

Two days after our arrival, I and my brothers visited Herr von Hartl in his country residence in Dornbach. We were received most kindly, and he

promised me his aid if I could give satisfactory proofs. So far as the franchise was concerned, however, he showed me that it could be taken out only in my name, and this, he explained, would be difficult enough, as all the art dealers were against it. To ask for it in the name of three brothers was out of the question. Neither, said he, would it be necessary, as I could make a separate contract with them through which they could be partners with me.

Herr von Hartl, who, as Court Agent, naturally knew all that was to be done, would not have said this without good reason. My brothers, however, were highly incensed, and declared that they would not be dependent on me, but would be their own masters. Had they possessed the money necessary to travel they would, no doubt, have carried out this resolve at once, for they had been angered already by the fact that Herr von Bogner kept only me as his guest. My representations were without effect. They told me that they would return to Munich and practice the Bavarian privilege in my name if Herr von Hartl would give them the journey money; otherwise they would be forced to listen to the proposition of several Viennese art dealers and sell them the secret of the stone-printing art.

As this would have destroyed all chance for getting an exclusive privilege, Herr von Hartl gave them the money, and Theobald and George Senefelder returned to Munich, after making a contract with me which permitted them to establish a printing business and, if possible, an art business, my share in which was to be one third of the net profit after deducting the cost of their own support. This contract was necessary to authorize them to practice under my privilege.

Meantime I had a small hand-press made and produced several pieces of work for Herr von Hartl, which gave him a clearer idea of the new art, and convinced him finally that it was worth while to risk something on it. He made a full contract with me, in which he bound himself to furnish money and everything necessary, and use all his influence to further the business, while I was to give all my time and knowledge. The profits were to be divided into two equal parts, one of which was to be his, while the

other was to be divided between myself and Herr Gleissner. He allotted a proper sum for my support, told me to rent a comfortable residence, and authorized me to buy some large presses. He told me frankly that the use of stone for cotton-printing had the most interest for him, and that he cared about the other forms of printing only as paying for our expenditures. When the big spinning-shops were ready, said he, he would give me so great an opportunity that I could let Herr Gleissner have all the art- and music-printing to himself.

What glorious prospects opened themselves to me! What could I think except that it would require merely industry to become a famous, happy man in a short period?

Here I must interpolate the account of a happening that brought about a total rupture with Andre. Until now our relations had not been wholly severed. His last word was that I would, no doubt, go to Vienna in vain, and in that case I should return to him, as he would receive me with open arms. When I saw his correspondent in Vienna and learned from him that he had orders to let me have money if I wanted it; when I perceived further that Madame Gleissner had been too hasty, and that all the tangle was caused by misunderstandings, I dismissed all anger and wrote to my friend Andre at once, telling him that I had found things not nearly so bad in Vienna as he imagined. It was true, I said, that the two women had failed to obtain the franchise, but mostly because they could give no demonstrations. It was quite different, now that the inventor himself was petitioning for it, especially as Herr von Hartl had promised absolutely to take our part. If, therefore, Andre were willing to spend at most one thousand gulden for a press and to pay for our support and necessary working expenses for six months, there would be absolutely no doubt of fortunate outcome.

Had I had the happy thought to ask Herr von Hartl to add a few lines, my letter might have had the intended result. But I considered my word sufficient, and unluckily my letter reached Offenbach when Andre was absent, and was answered by his brother in about the following fashion:

His brother, he said, was absent; but as he knew his opinion exactly, he

would not keep me waiting. I must not be offended, but he believed that my ready trustfulness, caused by my good-heartedness, had played me a prank again. He was completely convinced from the advices of their Vienna friends that the privilege would be granted only if his brother removed bag and baggage to Vienna and had himself naturalized there, something which his affairs did not permit. I would discover, soon enough, that the lovely promises made me were nothing but air.

Then he went on to say that even if the sum of one thousand gulden really were only a trifle, it would not produce the desired result. Madame Gleissner, said he, had incurred debts of one hundred and fifty gulden since she had broken with his brother, and as she had used this sum not for his good but rather for his harm, it was only fair that she pay it herself. I, probably, would be in debt nearly one hundred gulden, now that I had been in Vienna some weeks with my brothers. If I wanted to build a press in Vienna where wood is dear, it would cost easily one hundred and fifty gulden. Then there would be one hundred gulden for stones, etc. I would need a dwelling, for which I would have to pay at least one hundred gulden in advance. This would leave only four hundred gulden. The winter was at hand, neither my brothers nor Madame Gleissner had the necessary clothing, everything would be needed. In brief, he assured me, before many weeks the one thousand gulden would be spent and in the end there would be no press, no stones, and no specimen work.

Therefore, he concluded, I should not feel affronted if he told me his heartfelt thoughts. The aspect of the Vienna matter would, probably, be different if my over-great good-heartedness did not put fetters upon me that must prevent anybody from placing full confidence in my advice. I would better, therefore, dismiss the plans, and be sure that nobody meant it more sincerely with me than, etc.

It may be supposed that this letter gave me little pleasure; and I made up my mind to show Herr Andre that he had made a mistake and had thrown away a great profit idly. I made the contract with Herr von Hartl, and we went to work actively at once. I had a large lever press built and asked the Austrian Government to appoint a commission to examine the

process. This was done, and besides the Mayor, there appeared the factory inspector, Herr von Jaquin, who was a Professor of Chemistry, and the director of the academy of copper-plate engravers, Herr Schmutzer. I showed them the various methods of printing from stone on paper, cotton, and calico, and explained the difference of my process from all others. My demonstrations were applauded, and the commission certified most heartily in favor of my petition for the exclusive privilege.

In addition, Herr von Hartl went with me to a meeting of the Imperial Councilors, then to the Imperial Counsel of State, von Gruber, to Count Lazansky, and, finally, to His Majesty, the Emperor himself. Everywhere I had to make demonstrations with my little hand-press, at which time Herr von Hartl, to my great joy, always acted as cicerone and eagerly described the manifold advantage which the new art had for so many branches of the arts and sciences.

Everywhere we received praise and were promised the speedy issuance of the privilege. As, however, the matter had to take a regular course, and it was evident that some time must elapse, we petitioned meantime for a mere license to work, which we received within a few weeks, so that I was able to begin printing without further delay.

Herr von Hartl became more friendly each day, and opened for me the most beautiful outlook on the future. My easily moved imagination interpreted his speeches as brightly as possible, and I imagined that I saw fortune and position close at hand. I worked all the harder, therefore, to fulfill his expectations; and as his chief object was printing on cotton I threw myself zealously into the study of color, as absolute permanence was needed besides beauty of printing.

During this time Herr Gleissner had left Offenbach and had returned to Munich with his children. As I was in partnership with him, and he could make himself useful in the printing of music, Herr von Hartl decided to have him come to Vienna, and his wife took it on herself to get him and arrange for an extension of his leave of absence. She found him in the saddest of circumstances. In his ignorance of such things, he had sold all the furniture in Offenbach for a mere joke of a sum. Most of this money had

been used to defray his traveling expenses, and she found the family stripped of even necessaries. What was to be done? Her husband and children needed clothing that they might not make a bad impression in Vienna, her husband's debts had to be paid, and then came the traveling expenses. The money advanced by Herr von Hartl was not nearly enough for all this. She wrote to me to ask him for an additional sum of three or four hundred gulden.

This was exceedingly unpleasant for me. I should have to tell him the truth, and thus place Herr Gleissner in a bad light right in the beginning. Furthermore, he had received no too favorable a report about the domestic management of the two, either from Herr Andre's friend in Vienna or perhaps from Herr Andre himself. It was torture for me to ask him for money, especially if it was to be used for something not absolutely necessary for the business in hand, as I knew his opinions in that respect. Willingly as Herr von Hartl gave money when it was needed to achieve a useful object, so reluctant was he if he deemed that it was to be wasted. In my embarrassment I dropped a hint as to the situation to our hostess, Madame von Tannenberg. She counseled me at once not to ask, as the family would lose the respect of Herr von Hartl entirely, and offered voluntarily to advance Madame Gleissner four hundred gulden herself, if I would guarantee the payment of it in half a year. Nothing seemed more certain to me than that I could save such a sum in that time. I accepted her offer and sent the money to Munich on the same day. I would not mention this apparently trivial matter, if it were not for the fact that in the end it was the cause of the ruin of all my hopes in Vienna.

The dealers had spared no pains to oppose my franchise in the beginning, before they knew of my connection with Herr von Hartl, and while they still considered me an unimportant foreigner, who had neither friends nor influence. When they discovered the truth, their noise became clamorous, for they had to fear in earnest now that their trade would suffer, since so eminent and rich a man was associated with the new art. The more important art dealers feared it less than the smaller ones, among whom Herr Sauer and the new Industrie-Komptoir were my most active enemies.

Despite this, there opened a way suddenly by which I could make peace with the art dealers and even draw considerable profit from them.

Through Herr von Hartl, I became acquainted with a skillful clavier-player, Teuber, who was also a composer, and at once showed great interest in my invention. He spoke to his acquaintances, Herr Sonnleithner and Herr Ricci. Through their intervention the art dealers asked me if I would abstain from establishing a music-printery of my own, providing they guaranteed me a sufficient amount of work. I calculated that I could print six thousand sheets of music a day with the three presses that I had planned. This, at the low price of twenty-five kreuzer per hundred impressions, would amount in all to a sum of twenty-five gulden. Also if I accepted, say, work that would average three hundred impressions, there would be needed ten stones, counting two sheets to each stone. Thus there would be a further engraving profit of ten gulden, because I received fifty kreuzer for each sheet, but paid my note-writer only twenty kreuzer. For house, color, acids, polisher's wages, etc., there must be reckoned four gulden a day. The six printers to operate the three presses would cost four gulden a day also. Now if I reckoned two gulden a day for possible accidental errors, etc., there would still remain twenty-five gulden a day profit. This meant seven thousand and five hundred gulden clear profit in the three hundred working days of a year, without the least risk.

As I considered this a satisfactory profit for one single branch of my art, I told Herr Sonnleithner that I would attempt to induce Herr von Hartl to give up the idea of establishing his own publishing house, provided that the united art dealers would guarantee me that amount of work and agree also to reimburse me if the presses were not kept busy, excepting through my own fault. Herr Sonnleithner welcomed the proposal, not doubting that the dealers would need all the work stipulated, and, indeed, declaring that the Art and Industrie-Komptoir alone might give me twice that much.

I knew that Herr von Hartl had entertained little regard for this branch of work. Therefore I thought it would delight him to find that he could not only relieve himself from further expense in this line, but gain several thousand gulden. I was mistaken. He deduced that music-printing was

not so unimportant as he had imagined; and he told me to inform the dealers that I would take as much work as they offered at low prices, but that we could not make ourselves dependent on them.

As the dealers refused decidedly to give me the means with their own hands of building up a great establishment, the project fell entirely.

However, Herr von Hartl now had declared himself in favor of establishing a music-printery; and a few days later there came a highly favorable opportunity to start one at once under happy auspices, together with a complete art publishing establishment.

An acquaintance of my landlady, to whom I had showed my printery, sent for me to tell me that Herr Eder, an art dealer, wished to give up his business because of illness and was willing to sell reasonably. This friend enlarged on the luck it would be to obtain this well-situated shop, which earned several thousand gulden by printing birthday and New Year's cards alone, at the very easy terms which Herr Eder had suggested provisionally. He desired me to see him at once, under the pledge of secrecy, which pledge Herr von Hartl was to give also, as Herr Eder did not wish to injure his credit by offering his establishment openly for sale.

Herr Eder did, indeed, offer most favorable terms, according to my opinion. He showed me that on the average the net profit of his business had been ten thousand gulden annually during the last ten years. (At that time the gulden notes stood at par.) Furthermore he estimated the value of all his printed stock only at the cost of manufacture, and the great stock of copper plates, many newly etched, at merely their value as copper. The large stock of different papers, with the many writing and drawing materials, were estimated at cost value, also. For his trading rights, and for his excellent rental contract which had many years to run, he did not ask anything. The sum that he asked for everything was forty thousand gulden, of which only ten thousand gulden were to be paid at once, the rest being paid in annual installments during the following ten years.

If Herr von Hartl had accepted this, there would have been four thousand gulden net profit a year in it. And by combining with it the advantages of the new process, the profit was certain to be greater. To begin a

new publishing house without mercantile knowledge, without knowing what the public wanted, would be far more difficult than to continue one that already was in operation, especially so as Herr Eder had offered to remain for a year as associate to teach me the business.

I cannot yet understand why Herr von Hartl discarded this proposition. Perhaps he feared that he would be overreached in some way. He might have been more receptive had he been able to foresee that his new establishment would cost him a sum of twenty thousand gulden within a very few years without advancing toward being even the ghost of a business. Perhaps I did not possess the gift of convincing others. At any rate, both projects failed to meet with approval. That Herr von Hartl could be convinced, however, even to his plain injury, I will prove later. For lithography the failure of this plan was a great loss, because it would have given me opportunity to get into the art line ten years earlier than I did, and make useful application of my inventions.

The family Gleissner now arrived in Vienna and brought one of my former apprentices, Mathias Grünewald. Meantime some presses had been completed, and we could begin to print. Gleissner's symphonies recently had been much praised in a musical paper of Leipsic, and he proposed to us to begin with a few of his works. Of course it would have been wiser to begin with a good work by a famous man, whose name was sufficiently popular in Vienna. I did visit Herr Doctor Haydn, but received the reply that he could not compose any more and would only review old works thenceforth.

Immediately at the commencement a stock of stones was needed. As we could foresee that we should need some thousands of stones in the course of time, Herr von Hartl decided to make a trip with me, by way of Munich and Augsburg, to the quarries of Solenhofen that we might inform ourselves on the spot about the best way to get stones.

A further inducement to make this journey was that he wished to examine the estate of Niedau, which had been described as being very favorably situated for the erection of manufactories. Herr von Hartl already had a large spinnery in operation. This, and perhaps the printery,

he planned to establish in Niedau, because there both workers and property were cheaper. He intended to leave only the business offices in Vienna.

The establishment of this spinnery had so important an effect on my fate as well as on the future of lithography that I must describe it here. When I arrived in Vienna, Count von Saurau had just gone to Petersburg as Austrian Ambassador. Being a patron of home industries, he had advanced ten thousand gulden some time before to an expert spinner named Mistelbauer, to erect looms for manufacturing fine English and French stuffs in Austria, a work for which Mistelbauer was perfectly qualified. When the Count departed, Herr von Hartl took charge of several of his interests, among them the Mistelbauer spinnery. Thus at the next Vienna Messe (market-fair), Mistelbauer visited Herr von Hartl to make an accounting. The goods that Mistelbauer had brought convinced Herr von Hartl of his skill and technical capacity. The details of his processes, and his ingenuity in operating so many looms with so little capital, indicated to Herr von Hartl that increased capital would bring enormously increased results. As the spinnery company had as good as decided that a good part of their own products should be further worked by themselves, Herr von Hartl considered it a lucky circumstance to meet a particularly good weaver and also a cotton-printer, who alleged that he could print the home-made cottons exactly as well as the English printers and possibly at smaller cost.

He wrote to Count von Saurau that he was willing to assist Mistelbauer with more money. Count Saurau agreed, and Herr von Hartl advanced money to Mistelbauer till it reached a sum of forty thousand gulden. He appeared only as a creditor, however, and held a mortgage on the entire spinnery, with all its present and future stock, in order to be covered should the operations fail.

Now Mistelbauer was a man who had little or no mercantile talent. He did not understand book-keeping, and though he had managed the original small establishment pretty well, he was not equal to the bigger one. A factor should have been appointed to manage the commercial end and the

accounts. Another trouble was that Herr von Hartl, in order to satisfy himself, continually demanded new sample work from him, which, on the other hand, pleased Mistelbauer, as it enabled him to show his skill.

Thus, instead of working steadily along the original sound lines, he kept going into new things. Among others he erected looms to make color, and print Manchester fabrics. Regardless of the fact that I (as he well knew) was working at cotton-printing, and that Herr von Hartl intended to work my inventions, he managed to induce that gentleman to let him erect a cotton-printery, a matter which he did not understand in the least.

Mistelbauer had been a poor peasant boy of Helmannsöd by Linz. He had gone into foreign lands in his youth, but when he obtained the ten thousand gulden from Count Saurau, he selected his native place for the works. Even at that time his improved condition aroused the envy of the village; but he lived in a poor hut and differed in nothing from the other inhabitants. When Herr von Hartl assisted him, he succeeded soon in convincing him that they needed more room, and obtained his consent for building. Instead of erecting a factory, he erected a considerable dwelling, the cost of which was far beyond the original estimates. On account of all the other work undertaken at the same time, nothing could be finished in time, and Mistelbauer was continually too late for the markets with his product. As a result, instead of being punctual with all his payments as he had been heretofore, he could not even pay his interest, and Herr von Hartl had to make new advances all the time. Naturally Herr von Hartl began to feel apprehensive, and he decided to visit Mistelbauer on the occasion of our journey to Solenhofen.

When we reached Helmannsöd, Herr von Hartl shook his head dubiously, especially when he found the accounts in the greatest disorder. But the great stock of goods, though most of them were only half finished, and the thought that everything could be made to go smoothly again with better management, encouraged him, and he instructed Mistelbauer, showing him how to establish order in his works as well as in the accounts.

Then we continued our journey. In Munich, where we remained three days, I visited my mother and my brothers, who all lived together and

were operating a press that worked mostly for Herr Falter. According to their assurances, their income had hardly sufficed to support them.

In Augsburg, Herr von Hartl contracted with a paper dealer for the paper necessary for music-printing, and in Solenhofen he bought several hundred stones for this work and made arrangements for future supplies. Then we returned through Regensburg and Passau. This whole journey was one of the greatest pleasures of my life. The weather was excellent, and Herr von Hartl was so kind to me that I was more than ever convinced of his sincere desire for my success.

We engaged two writers of music immediately on our return to Vienna. One was J. Held, a young man recently married, who earned his living by teaching and copying. The second was his brother-in-law. They comprehended the process quickly and soon were so skillful that each earned twelve gulden and more a week, despite the fact that we rarely paid them more than twenty and twenty-four kreuzer for each sheet.

The new smaller works of Herr Gleissner were finished very soon, and it became necessary to find more work to keep my etchers and four printers busy. I asked Herr von Hartl to buy some compositions from Vienna's best musicians, such as Krommer, Beethoven, etc. He was willing, but desired to wait for a proper opportunity to speak to Herr Krommer. Thus some weeks passed, and in order to keep the force busy, Herr Gleissner composed continually and printed his work. Nearly a whole year passed that way, and still Herr von Hartl had found no opportunity (owing to his many affairs) to arrange with Herr Krommer or other composers.

So it happened that, with the exception of a few overtures, our whole stock of paper and a whole year's work were used solely to print Herr Gleissner's compositions. I myself had hardly anything to do with this printing, which was managed entirely by Herr Gleissner; for I devoted all my time to the study of color and to the necessary thousands of experiments.

Here I had made the unpleasant discovery that most of what was in the books was incorrect, or so incompletely stated that, before one could understand the instructions, one needed to know the entire process of cotton-

making and printing. I cannot understand now why it never struck Herr von Hartl or me that I did not need this knowledge at all, and that all that was necessary in order to apply my method to cotton-printing was for me to demonstrate how the printing could be done well and quickly. To get color results it was necessary merely to engage a good color expert, who could analyze colors and decide if they were available for my process. That would have saved us a year and a considerable sum of money which my experiments had cost. I confess that I had a mistaken ambition on this point, wishing to understand everything myself. Then the study of chemistry was most attractive to me, because I found myself discovering new things of importance for my art all the time.

When at last I was completely informed in the matter of color, I went with Herr von Hartl to the great machine-spinnery in Pottendorf. Here I became acquainted with Herr Thornton and his remarkably complete installation. With his assistance we made a stone-press for cotton, to print the cotton from large plates. But the correct register of each impression made so much trouble for us that I foresaw the need for many further experiments and inventions. Besides, Herr Thornton was too partial to the English process of cylinder-printing to feel particularly favorable to the stone-process; and in the end it was considered best to order a great piece of stone from Solenhofen from which we might make an eight-inch cylinder.

It was six months before we obtained the requisite stone. During this period it struck me that perhaps the cylinder did not need to be stone, but that we might use copper cylinders, as in England. Herr Thornton objected that copper cylinders must be engraved with the graving tool, and that patterns for cotton should not be etched, since, if etching were practical, the English, who understand etching perfectly, no doubt would etch the cylinders.

To be sure, I could not answer this argument, but I was convinced that a deep-etched stone would print as perfectly and handsomely as the best copper plate. Why, then, could it not be done with copper, since copper permitted itself to be etched so well? I made a little experiment at once,

and it succeeded perfectly. Herr Thornton proposed to make completely sure. He had a small model press from England, the cylinder of which had been engraved by the best cotton copper engraver of England. Though it was only six inches long and three inches thick it had cost twenty pounds to engrave. He proposed to have an exactly similar cylinder made, which I was to etch in the same design, so that competitive impressions could be made with both cylinders. The proposition was accepted. To save money, it was decided to make a cylinder from zinc instead of from copper.

After a few days it was ready and I drove with Herr von Hartl to Pottendorf, where we arrived at half-past ten o'clock in the morning. I started eagerly to do the drawing. As I perceived immediately, it consisted purely of circular lines, and therefore I succeeded in preparing the cylinder, drawing the design, and etching it before two o'clock, at which time we were to have luncheon.

Mr. Thornton, who had expected that I would need at least eight days, was astonished by my speed. To all appearances, the etched cylinder was as good as the engraved one, and now it was merely a question of the printing. He made the first impression with the copper cylinder, which, of course, produced a very pretty piece of work. But when mine was adjusted and the first impression came out, the astonishment of all present reached its maximum, for the impressions were exactly as clear, but at least twice as strong and therefore more beautiful. The reason for this was that the engraving became narrower at the bottom, and therefore held hardly half as much color as the etched lines.

The practicability of my etching process was settled; and Herr von Hartl waited only to lay the matter before the society at the next general meeting before proceeding to its exploitation on a large scale.

Truly it was high time for him to get some returns for his many expenses. The stone-printery had cost him at least six thousand gulden to this date. In return for this investment he had a good quantity of stones, several presses, and a great stock of Gleissner's music, which represented an income of twenty thousand gulden, if it could be sold.

At last we obtained the long-sought franchise (in 1803), and Herr von Hartl decided to begin the business. I proposed to him to rent a shop and engage an experienced man to manage it. But he replied that I was merely suggesting another burden of nearly two thousand gulden a year, with no certain prospect of a penny's income. Rather, said he, I was to give the finished work to the dealers and let them sell them on a percentage, so that we could see how the public liked stone-printing.

Herr von Hartl was trying at this time to rid himself of all expenses that were not absolutely necessary. He was growing more and more dissatisfied with Mistelbauer, his health was poor, and irritating business troubles were anything but good for him. He expressed his regret many times because he had undertaken so many things. His many enterprises, which up to this time had proved anything but profitable, took so much of his time that he had to give up his far more advantageous interests as Imperial Court Agent, and thus lost heavily in that direction also. The stock of spun wool kept piling up in the company's magazines, and this, too, seemed to promise no greatly satisfactory results.

However, I could see that I could expect only small sales in Vienna if I depended on the dealers, who were my opponents and would hardly be very eager to aid my success. Therefore, I conceived the thought, equally unpractical, as it turned out, of putting our work into the hands of a book publisher; and as I had just observed much empty space in the shop of Peter Rehm's widow, I agreed with her to turn over our stock to her at twenty-five per cent discount.

It was arranged that there be an accounting each month, and I looked forward to the end of the first month with great impatience, because I hoped for a considerable income. It was highly necessary, to help me pay off the debt that I had loaded on myself to defray Herr Gleissner's traveling expenses, — a debt that now had stood for two years, and that the skillful manipulations of my dear landlady and her faithful legal adviser had increased from four hundred gulden to two thousand. Many times during the month I inquired as to the sales and received the answer that they were good. I was satisfied, and did not require further statements, as I did not

wish to anticipate the pleasant surprise that I expected when the month's accounting was made. But alas! How I was shocked at the end of the month when the sum of ten gulden and forty-eight kreuzer turned out to be all! I did not know how I could appear before Herr von Hartl with the news. My walk to his house was one of the bitterest of my life. I was not received as badly as I had expected. On the contrary, Herr von Hartl comforted me and advised me to have patience, that all beginnings were slow, etc. In short, I enjoyed the most pleasant anticipations again. Unhappily, at the end of the second month the accounting gave us one gulden, thirty-six kreuzer. Now the patience of Herr von Hartl reached its end.

He had just lost heavily again in the Mistelbauer affair. It worried him seriously, and as his health continued poor, he inclined to listen to the advice of his wife, who represented to him that he did not need to burden himself thus, and that he would better pocket his losses and retire from all the matters that worried him.

Therefore, when his secretary, Steiner, advised him to send a certain Grasnitzky to Helmannsöd, he accepted the suggestion, and Grasnitzky went there with unlimited power to do what he thought best. Now of course it was vital that Grasnitzky be absolutely honest, as otherwise it was certain that he would make the worst possible report in order to get everything into his own hands. Hardly had he made a superficial inspection before he reported that Herr von Hartl was being cheated by Mistelbauer. As soon as he had driven the man and his family out of the house and had gained possession of the finished stock that was on hand, he took away everything that was in the hands of the local weavers, and transported it to Linz to be finished and sold.

Hardly had Herr von Hartl received the alarming news that only the highest degree of commercial talent could save the capital that he had invested in this business, before worse news came. While Grasnitzky was in Linz, fire started in Helmannsöd and spread to Mistelbauer's house, which Grasnitzky had locked up. The peasants saved their own houses and were not at all displeased to let the handsome new building, with all its machinery and stock, burn down.

The hard blows were too much for poor Mistelbauer, who was now reduced to total beggary. He became ill and died soon afterward in great misery. Nothing was left now except for Grasnitzky to finish the goods he had saved, and to sell them as well as possible.

Naturally the loss was considerable, despite all efforts; and of course it was an unfavorable circumstance for me that this affair should be contemporary with my failure to sell the sheet-music. Herr von Hartl lost all hope of success with stone-printing, and probably would have given it up entirely, had his secretary, Steiner, not advised him to continue. He pointed out that the small sales were due not to the printing, but to the unwise selection of work, which was almost wholly the composition of a composer quite unknown in Vienna. He said that they needed a man as manager who had the necessary knowledge and who also had a good shop for making sales, and that thus stone-printing would become a veritable gold mine. He proposed the antiquarian Grund, who had a shop in the same street as Herr von Hartl's house. Herr von Hartl agreed.

I was informed that hereafter I was to communicate only with Herr Grund about work, and that he would make all payments in Herr von Hartl's name, select the works to be published, and make quarterly accountings, at which he would deduct thirty per cent for himself.

I was glad, because it relieved me of many cares and I foresaw success once more. New life came into the work. We hired two more writers, and printed bravely. Grund succeeded in inducing Herr von Hartl to increase his investment during the first year so that the original capital of six thousand gulden that was already sunk in the work had grown to twenty thousand gulden. But when at last the fourth quarter passed without an accounting from Grund, and still there was no dividend, he lost patience again, and no doubt Steiner had to bear some censure because of his unfortunate suggestion. To soothe his master he proposed to take everything out of Grund's hands and establish a publishing house. As this would demand more capital, Herr von Hartl declined, being quite sated. Then Steiner came out with the project: he would seek to induce Grasnitzky, who had done so much already, to undertake this business also; he added

that he himself was disposed to put in some capital and take a personal part in the business, for a third part of the profits.

Just then I was in fatal embarrassment. The legal adviser of our landlady pressed harshly for payment. He even went to Herr von Hartl. That gentleman sent for me immediately and declared that he would try Steiner's plan, and that it would be his last attempt, and that I could see myself that there was nothing else to do. Since he promised to pay my debt, and I hoped for good results anyway from Herr Steiner's coöperation, I agreed willingly.

Now passed another year, during which a number of pieces of music were printed under Grasnitzky's and Steiner's directions, and some experiments made in art work. An artist, Karl Müller, learned to draw nicely on stone partly with the pen, partly with the brush. Among many, often very excellent efforts, one of his most successful was a copy of Preissler's drawing-lessons. The first number was printed under my direction and came out very well. The other numbers, which were printed when I was in Munich again, were reported as not having been so good. The reason probably was that they were printed with a new press ordered by Herr Grasnitzky, which did not have the power necessary for printing from stone, thus making necessary a softer color not satisfactory for pen-drawing. In the end Herr Steiner is credited with having improved this press very much. I shall describe it in its most complete form in my description of presses which will follow.

Judging from the amount of printing done, Steiner and Grasnitzky appeared to understand their business. In a short time they actually printed a second impression of some of the Gleissner compositions, which met with good sales, especially in Poland.

I was delighted with this activity, especially as I hoped for a part of the profit for myself at the end of the year; but Herr Steiner, instead of accounting to me, assured me that I could entertain no hopes for ten years, as Herr von Hartl's investment of twenty thousand gulden would have to be repaid before there could be any question of dividing profits. I realized what this meant; and to avoid bringing a lawsuit, for which I lacked the

means anyway, I decided to sell Herr Steiner my interests. He offered me six hundred gulden, and when, at last, I accepted it, he paid me fifty gulden because he had a claim on Herr Gleissner for five hundred and fifty gulden, something of which I had been in ignorance.

The loss of this business pained me, but Herr von Hartl comforted me with the example of other inventors, who had received no better returns.

Now the cotton-printery was my only hope. A third of the Pottendorf Company had declared itself in favor of erecting a factory, and in fact one thousand two hundred gulden had been appropriated to make a trial on a large scale. I went to Pottendorf and ordered a machine in which the cylinders were of cast-iron instead of copper, because Herr Thornton had two very handsome iron cylinders, two yards long and eight inches in diameter, which had been intended for another purpose but were sufficient for my trials.

As soon as the printing-machine was ready, Herr Thornton had it connected with the water-wheel of the cotton-spinnery, so that one needed only to pull a cord to set the cylinders in motion and see the printing of the cotton proceed without human help, as if of itself. Nothing was needed now except to etch the design in the upper cylinder.

The design consisted of a simple little flower, many times repeated, and it seemed to me to be anything except difficult. But after I had covered the cylinder with the etching surface and started to work with the graver, I saw, after a very few strokes, why it had not been possible before this to produce cotton patterns by etching and why engraving had been necessary.

It was not possible for me to draw even three of the little flowers into the etching surface with the free hand so firmly and evenly as this sort of printing demanded if it was to appear thoroughly accurate to the eye. This was in spite of the fact that I had first drawn the design carefully in measured squares on stone and transferred it in red to the black cylinder. My strokes were too trembling and uneven, so that I nearly gave up the hope of ever doing anything excellent in this way, unless I were to expend as much or more time than would be needed for the regular process of engraving.

The failure of this attempt, and the disgrace that would come to me as a result, spurred me on to invent some method to overcome the difficulty of drawing. I succeeded so unexpectedly that the very failure became the means to greater perfection.

To cover the entire surface of the cylinder it would be necessary to draw thirty thousand flowers. Had I not experienced the slightest difficulty, I still would have needed half a minute for each flower, and thus I would scarcely have been able to finish an entire cylinder inside of a month. But I invented a drawing-machine with which, though I was not a skillful draftsman, I could draw the entire design within two days, and with an accuracy that hardly could be attained by the engraving-tool. With this instrument I drew the design on the black etching surface of the cylinder, etched it and made a sample printing which, when it was repeated afterward in presence of Fürst von Esterhazy and other members of the company, earned universal praise.

Herr von Hartl planned to obtain an exclusive franchise for this cylinder cotton-printing, sell it to the company, and have me appointed as director, something like Herr Thornton, who drew not only a decent salary but also a fourth part of the profit from the entire spinnery. As I could see readily that a company with such enormous resources could soon bring a cotton-print establishment to a great stage, it did not seem impossible to me that the annual income might rise to a million, as in the Ebreichsdorfer factory. If the net profits were only five per cent, there still would be more than twelve thousand gulden annually for me, and I was sure to be a rich man in a short time. So I thanked Herr von Hartl heartily and continued to perfect my process in every tiny detail.

The fear had arisen that iron cylinders might affect the handsome reds and other fine colors. Herr Thornton, who had become my friend, promised to make for me cast copper cylinders with iron cores: and his preparations for this work were almost completed when again fate ruined all my hopes.

Napoleon had just completed the Continental blockade; and the English cotton stuffs were not to be had anywhere. This forced all the weav-

ers and manufacturers of the inland to buy from the Pottendorfer Works, and the sale of their output became so great that the formerly overcrowded storehouses were emptied in a short time. "Why should we erect a new, different factory? Rather let us enlarge the present one." This was the general and entirely sensible decision of the company. Herr von Hartl would not interest himself further in the process, because our hope of an exclusive franchise had been ruined through the treachery of a foreman in the spinnery, who had made drawings of our machine and sold them to various cotton-making establishments, who were already imitating the process. So there was nothing left for me except to seek my fortune elsewhere.

In my pain over my oft-ruined hopes I complained to a good friend, Herr Madlener, a tinner in Pottendorf, and this noble man was ready at once to seek another opportunity for me. The very next day he told me that a cotton-printer in Vienna, Herr Blumauer, would pay me five hundred gulden for a small model press for cylinder printing on cotton. This turned out true. Fourteen days later he made me acquainted with the brothers Faber, who had a cotton-works in St. Polten, and who, on Madlener's recommendation, made an extremely satisfactory contract with me for the erection of a complete cylinder printery.

I thought myself happy to come into relations with this firm at whose head were two of the noblest of men, and was just ready to go to St. Polten, when my destinies received a new direction through a strange chain of circumstances, that opened for me an excellent prospect again of making great advances in improving my lithographic invention.

My brothers had written to me several times while I was in Vienna, complaining about scarcity of work and their resultant poverty. Therefore it is not to be wondered at that I did not exactly long to return to Munich, despite the fact that my hopes in Vienna had become steadily less. Probably I should have returned again to Herr Andre in Offenbach, as Gleissner and his family were pretty well placed with Steiner and Grasnitzky, had not Madame Gleissner conceived the idea of making personal inquiries about the conditions in Munich.

Shortly before, a Bavarian court musician had visited Vienna and had visited his friend Gleissner. From him we learned that my brothers were doing very well. They had good positions with the Feyertag School and had sold their franchise for stone-printing to the Royal Government. It was even reported that they had formed a company with Herr von Hazzi to establish a press and publishing house, and that they expected to get a comfortable building from the Government.

Madame Gleissner went to Munich at once and ascertained that the report was true. She also met our old apprentice, Grünewald, who had left Vienna in 1804 with one of our note-writers, Held, to erect a stone-printing establishment for Breitkopf and Härtl in Leipsic. He had just returned to Munich, and he induced Madame Gleissner to join him in erecting a small printing-house, which she did all the more willingly, since she hoped that it would earn her expenses for her in Munich. This occasion led to her acquaintance with Abt Vogler, who gave her several pieces of music to print.

Stone-printing pleased Abt Vogler so much that he proposed to Freiherr Christoph von Aretin, Royal Court and Central Library Director, to establish a printery and take into partnership the inventor as well as Herr Gleissner. Freiherr von Aretin was willing, and they made a provisional contract with Madame Gleissner, under which I and her husband were to go to Munich and establish a stone-press, for which Freiherr von Aretin and Abt Vogler would furnish the money.

I was pleasantly surprised when Madame Gleissner returned to Vienna with this news. Freiherr von Aretin was one of my old schoolmates in the Munich Gymnasium; and as he always used to gain the first prize in everything from the lowest class to the highest, I had entertained the greatest respect for him since youth. I would have thought myself fortunate even then to make his nearer acquaintance, because I ever have had a decided admiration for remarkable persons.

In later days it happened once that my mother dwelled in his house and could not pay her rent, owing to certain misfortunes, and when she asked him to excuse the delay he made her a present of the entire sum. This

proof of a noble soul was not calculated to lessen my regard for him. Therefore I snatched at the proposal with joy.

She had been urged earnestly to hurry matters, as Abt Vogler had various works which he wished to have printed as soon as possible. Unfortunately my contract with the brothers Faber, which I had signed the day before, would have delayed me for many months. I tried, therefore, if I could induce them to permit me to spend a few months in Munich before I started their work in St. Polten. The excellent men agreed gladly, and even advanced money to me that I might have various copper cylinders made in Munich, so that I would be able to go ahead without delay later in St. Polten.

PART III

FROM 1806 TO 1817

I LEFT Vienna with Herr Gleissner and his family in October, 1806. First we traveled to Cloister Atl near Wasserburg in Bavaria, which Freiherr von Aretin had bought recently, and where Abt Vogler awaited us. He proposed to erect the printery in the cloister; but when he saw that I was not at all pleased with the idea, he started with us for Munich.

Hardly had we arrived there before Abt Vogler suggested several plans which all contemplated only his own profit, and which would have redounded to Freiherr von Aretin's disadvantage. When he realized at last that we would not agree to his demands, and when Freiherr von Aretin insisted that Herr Vogler pay his share of the capital at once and in cash, instead of paying it by furnishing music whose value he set very high, he severed his connection with our company. There was also the added reason that the Royal Academy of Sciences did not reëlect him as a member, a fact which made him wish to leave Munich as soon as possible.

At this time a former workman of my younger brother Karl, a man named Strohhofer, commenced a printery. Madame Gleissner stopped this unlawful violation of our rights with the aid of the royal police, and this impelled Strohhofer to seek Abt Vogler, probably in order to gain his intercession with Freiherr von Aretin.

Vogler thought that he had made an important discovery, as the man knew how to speak very impressively of his knowledge and skill. He imagined that he could publish his works without our aid, perhaps even without cost. Therefore he promised to assist Strohhofer, made an appointment with him for a future day, and suggested to him how he could support himself meantime by selling the secret of the art.

Stuttgart was one of the towns suggested to him. Strohhofer circulated a pompous proclamation there, boasting of his talents and offering his services to anybody and everybody. Thus he came into communication with Herr Cotta. The inferiority and incompleteness of his knowledge were perceived very soon; but as even the imperfect results hinted at the importance of the new printing process, the result was that finally, through the assistance of an art-lover, Herr Rapp, the book, *The Secret of Stone-Printing*, was published by Herr Cotta. It was the first publication that showed true appreciation publicly of the art.

Immediately in the beginning of our establishment in Munich, our enterprise gained brilliant aspects through Freiherr von Aretin's activity. Several presses were operated, for music, for governmental work, and even for art. Then came the publication of Albrecht Dürer's *Prayer-Book*, which gave us an honorable reputation. This work was acclaimed by all art-lovers, and the conviction gained ground everywhere that the new process which hitherto had possessed few friends, was not so unimportant as had been believed generally.

The professor of the Feyertag School, Herr Mitterer, had done important preparatory work in Munich to gain a favorable decision. My brothers had imparted to him the entire process. He had found that the so-called crayon process, of which I had shown proofs as early as 1799, was best adapted for his purpose of reproducing elementary drawing-lessons, and he had succeeded in inducing the Government to establish a lithographic institute under his direction, in which my brothers were employed as lithographers. To be sure, this was a violation of my franchise; but the reason was that the authorities supposed my brothers to be the owners of the franchise, both on account of the name and because they had conducted the Munich printery for some years in my name.

Freiherr von Aretin counted on the sole use of the franchise, which he had believed to be unassailable when he formed our company and advanced the necessary money; but when in time he complained because the Royal Government as well as private persons established printeries, he received the reply that the art had long ceased to be a secret, — as if a con-

dition of the franchise had been that a useful process must be kept secret. In that case I could not have employed any man either for drawing or printing, as that would have involved the loss of secrecy and thus the loss of the franchise.

My connection with Freiherr von Aretin lasted four years. During this time I turned out a great amount of government work, such as circulars, statistical tables, charts, etc., besides many specimens in various forms of art. At that time the idea was first conceived for the present text-book of lithography, and, indeed, we published the first installment of the sample plates. Still, our enterprise was far less successful than Freiherr von Aretin and I had hoped.

It was very difficult to obtain skillful workmen, especially writers and artists. Even Strixner and Pilotti, whom we had engaged and who worked at producing facsimiles of the Royal Manual Drawing Cabinet, were very slow to gain the necessary perfection and speed. And again we lacked the manager, namely, a man who understood business and knew what to produce and how to sell it.

I myself was heavily burdened, as I had not only to exercise continual supervision of the five presses, but also was practically the only one who could prepare the plates for those presses. Added to this was the fact that the printers were almost all uneducated men, some of whom could not even read, and they spoiled many plates that I had to reproduce. This caused so much loss of time that already was insufficient, that it is no wonder that several presses came to a standstill frequently. Luckily there were government jobs at times that demanded fifteen thousand and more impressions. This enabled me to prepare new material while the presses were busy. On the whole, however, this work had the disadvantage of demanding such speed that usually all the five presses had to work at it, so that, when it was done, they were all at a standstill together, sometimes for weeks; and then the wages, etc., consumed the previous profit, so that in the end little or nothing was left.

Thus it was natural that Herr von Aretin, who was being annoyed at this time by other affairs, began to lose his enthusiasm for lithography.

Therefore, when he had to go to Neuburg as Governmental-Director, and could not participate personally any more, and when, at the same time, Herr Gleissner and I obtained situations with the Royal Tax Service, he sold the establishment to Herr von Manlich, the Director of the Royal Gallery, and to Herr Zeller, a merchant.

Although our connection was broken in this manner, and despite the fact that we had not won the expected results, still stone-printing had attained respect and support through Freiherr von Aretin's patronage. We had to thank him for the fact that our institution was praised by the most celebrated native and foreign statesmen, and even by their Royal Highnesses, the Crown Prince of Bavaria and his most noble sister Charlotte, present Empress of Austria. Our beloved Crown Prince wrote on paper with the so-called chemical or stone-ink, "Lithography is one of the most important inventions of the century." And his noble sister wrote the short but eloquent words, "I honor the Bavarians!" These lines were printed on the stone in their presence.

His Royal Highness the Crown Prince exhibited so much interest in this Bavarian invention that he condescended to order the sculptor, Kirchmeier, of Munich, to model my bust in plaster, so that in the future, when lithography should have attained an honorable place in the whole public estimation, it could be carved in stone and erected among the most celebrated artists of Bavaria.

In general my connection with Freiherr von Aretin had given me several well-founded prospects for an active and honorable future. He promised that, when his circumstances permitted, he would put me into position to use my entire time only for making useful inventions, for which purpose I should have all the material and workers that I might need. We would then investigate all branches of art and industry, to discover possibilities of improvement. He possessed the true viewpoint, appreciating how I could best be useful to the fatherland, and perhaps to all humanity. I shall ever consider it as my greatest misfortune that circumstances made it impossible to carry out this plan, and thus to justify the great confidence that he reposed in my inventiveness and ability.

A second beautiful hope arose in France, where I was encouraged by Freiherr von Aretin to expect the management of an imperial lithographic institute, with a great financial allowance, Herr von Manlich, and the French artist, Herr Denon, who was in high favor with Napoleon, having made strong efforts to that end. This hope also met disappointment owing to the circumstances of the times.

A third hope of no less importance was to erect a cotton-printery in Munich or Augsburg in association with His Excellency Count von Arco, Court Chamberlain of Her Royal Highness the widowed Kurfürstin of Bavaria. This was ruined by the clumsiness of a Munich wood-turner, who made such uneven cylinders that we could not produce any satisfactory specimens. Although I made arrangements at once for a large English machine, like those used by Mr. Thornton, its manufacture was so slow that two years elapsed, and during this time our entire lithographic establishment was dissolved.

The idea of a cotton-printery was an unfortunate one, which not only cost much time and a great sum of money, but also had the unpleasant result that I could not fulfill my contract with the Faber brothers and thus, in addition to the resultant personal financial loss, had the pain of appearing before these most noble men in a poor light.

All this trouble was caused as follows. On invitation of Count von Arco, his brother-in-law, Count von Montgelas, Royal Minister of State, visited our institution and examined our work. At the request of Freiherr von Aretin I made an experimental printing with the little model cotton-printing press that I had brought from Vienna. It won his approval. Freiherr von Aretin intended to ask for a franchise for this process in Bavaria, where it had not yet been introduced. The Minister promised this and also held out the hope of a considerable financial assistance from the Government. Then I was foolish enough to try to increase his interest by telling him of the value that foreign lands set on this process, and thus I informed him of my contract with the Fabers. But this had an unexpected result. His Excellency heard the information most ungraciously, and said that I must not hope for the least assistance in Bavaria if I permitted

myself to be used for the advantage of another state. He even declared that there was a royal rescript forbidding Bavarian subjects from using an art in foreign lands if its exclusive use were of importance for Bavaria. This rescript, said he, fitted my case exactly, and it was forbidden to me, under pain of highest disfavor, to proceed farther with the Austrians.

This embarrassed me mightily. Freiherr von Aretin and Count von Arco promised to urge the Minister to permit me to go to Vienna, on the ground that this method of printing cotton was no invention of mine, having been used long ago in England and for some time in Austria. But Freiherr von Aretin was not very desirous that I should absent myself for several months in the very beginning of our enterprise, and thus time passed without the hoped-for permission.

As the Fabers pressed me earnestly to fulfill my agreement, I devised a subterfuge that might permit me to keep my promise and still not lay myself open to too great a responsibility. I wrote to them advising them to have their correspondent in Munich demand through the court that I be forced to fulfill the contract. I considered that the city courts in Munich would have no particular knowledge of the royal rescript or, at least, that they would not immediately remember it, and that, when I admitted the existence of the contract, they would command me to keep it at once. Then I would obey immediately, and afterward could justify myself with the Bavarian Government by pointing to the court's decree.

It would surely have succeeded had not the correspondent of the Fabers failed in business after bringing suit, owing to which the matter got into another lawyer's hands. This man immediately adopted a new strange course. Instead of demanding a fulfillment of the contract, he sued for twelve thousand gulden damages for their loss of time. Of course I had to fight for my skin now; and as he refused to content himself with my agreement to fulfill the contract, I was forced at last to defend myself by falling back on the royal rescript. Thus I escaped by merely repaying the money already advanced; but I lost the considerable sum that would have been assured to me had I been permitted to spend only two months in St. Polten.

Thus none of the good prospects that opened themselves through my connection with Freiherr von Aretin proved so good as I had been justified in hoping: nay, it seemed as if I had only labored day and night to give others the benefits accruing from my painful labors, while I barely supported existence.

Freiherr von Aretin wished that the management of the business be in the hands of a man who possessed his own fullest confidence, but whom I did not consider at all suitable, as he was a royal official and as such could not do business in a public shop. Consequently the trade was carried on in his own residence, which was known to only few people and where nobody looked for the manifold things that we could have produced to good profit. This at last lowered our establishment to a mere job printery, which finally could not maintain itself, because more and more similar establishments were started in Munich, and the prices for work became lower and lower through their hungry competition.

It may not be uninteresting to tell briefly how so many printeries happened to be undertaken.

The first was established by Gleissner and myself, and was continued afterward in my name by my brothers Theobald and George, until 1805. They sold the secret to the Feyertag School, where an excellent art institute developed gradually under Herr Mitterer.

Strohhofer learned the elements of the process from my brother Karl, and associated himself, in 1806, with Herr Sidler, royal court musician, who had studied first with my brothers, then with Madame Gleissner, and then in the Aretin printery. When Strohhofer left Munich, Sidler erected a stone-printery for the Government, and after he had obtained an official permit before the expiration of my franchise, he established his own institution, producing very good work.

During this time Madame Gleissner had petitioned the Government frequently for sufficient work to assist her, and had obtained the promise through His Excellency the Minister of State, von Montgelas. Then it happened that the chief of a newly organized bureau, Freiherr von Hartmann, having a great deal of writing to do in beginning his new work, decided to

introduce lithography for the purpose of saving labor. His intention was to have it all done in our institution. No doubt he had communicated this plan to von Montgelas; for as he met Madame Gleissner about this time, and she asked again for work, he said that he had given Senefelder enough work to keep ten presses busy, and if he had not yet received it, he would get it soon through Freiherr von Hartmann. There evidently was a misunderstanding here on account of the name. When Freiherr von Hartmann sent one of his subordinates to call Senefelder to him, he brought my brother Theobald, who immediately got orders to establish a lithographic office, and shortly afterward was appointed Inspector of Lithography. Beside a considerable salary, he received the following other incomes, first, excellent pay for all work that was turned in; second, an agreement that if his ten presses could not be sufficiently employed by the bureau, he might work for other governmental bureaus and for private persons. Thus he received a great deal of work, among other jobs the printing of passports for the Ministry of Foreign Affairs, which earned large sums for him in a short time and placed him in very good circumstances.

He could not conceal his good luck, and so it came that many people imagined that stone-printing was a means for getting rich quickly, which resulted in a disproportionate growth of new shops. Out of his own there sprang two, namely, those of Helmle and Roth, who erected their own printeries under the permit of the police.

At the same time a lithographic institution was erected in the Royal Asylum for the Poor on the Anger; and a Herr Dietrich, of a government bureau, also established one.

My own prospects became worse and worse toward the year 1810. Though I may flatter myself that I perfected myself very greatly through unceasing practice and thousands of experiments, still, without a fortunate accident, it might well have happened that I would have been forced to think it lucky if I could obtain work under one of my former apprentices.

I even suffered the insult of having the papers declare that though I had invented the art roughly, I had kept it secret for a long time through selfishness, and had never understood how to use it for anything except

merely printing music. The falsity and humiliating character of this statement were bound to pain me the more bitterly, since all other stone-artists and stone-printers had learned only from me, and not one (not even Herr Mitterer, the most expert and, perhaps because of that, the most modest) possessed the art as a whole, in all its parts, as perfectly as I did. I hope that my text-book will prove this.

So far as the secret was concerned, the statement was an evident falsehood. Since the moment when I received the exclusive franchise in Bavaria, in the year 1799, I had made no secret of any part of my process toward any living being. I showed the whole manipulation to my workmen as well as to all strangers. Those who knew me more intimately and realized, therefore, that I could not resist the desire for communicating anything that I discovered to benefit mankind, often censured me severely for my frankness, saying that I could have been a millionaire had I kept my art a secret. But this was equally erroneous. I never could have succeeded to any degree with my own means.

The false belief that I desired exclusive enjoyment of the results of stone-printing, is in direct contradiction of the fact that the lack of secrecy was held to invalidate my exclusive franchise. The idea may have arisen, at least partly, through the circumstance that several of my former workmen, or others who learned something of the art, made a wonderful secret of it, in order to be considered more important. This was carried to such an extent that some traveled from place to place and sold their knowledge to many people for large sums under the seal of confidence. I pity those who thus received in exchange for their money something of little or no use, when they could have learned from me for practically nothing, as it always was my greatest delight to converse with intelligent men about those subjects that interested me so deeply as inventor.

After making this little excursion, which was needed for my justification, I return to my story.

There were, then, in 1809, six public printeries in Munich besides mine, without reckoning those which several artists had made for their own use. The foremost among the latter was Herr Mettenleithner, Royal Copper

Plate Engraver. He was one of the first to whom I had shown specimens, as early as 1796, of the new process, but he had paid little attention to it. Partly through various very excellent specimens from Herr Mitterer's print, and partly through the work of Strixner and Pilotti, he was induced to make experiments. A son of Herr von Dall' Armi, who was taking lessons just then in drawing and copper etching for his own pleasure, interested himself in the process. As a result, the latter established a lithographic institution in Rome, which, so far as I know, never achieved any decided success.

Soon afterward Herr Mettenleithner, in association with one of the best of the Aretin printers, a man named Weishaupt, laid the foundation for the stone-printery of the Royal Tax Commission (Königliche Unmittelbare Steuer-Kataster-Kommission), which is now the most important of all the lithographic institutions of Munich. A little later a similar institution was founded for reproduction purposes by the Royal Privy Council, through Herr Mettenleithner's son-in-law, Herr Winter.

Herr Mettenleithner was appointed director of the great establishment, which employed some thirty engravers, to etch the plans of the Steuer-Kataster, which received fifteen to twenty thousand impressions each. At this time the Kingdom of Bavaria was being charted in great detail for tax-regulation purposes, under the management of Privy Councilor von Utzschneider, the man who has done so much for Bavaria's home industries. There were required at least two exact copies of each map, and close calculation proved that it would be possible to etch the charts on stone and make several hundred impressions for the money that these two copies would cost if done by hand. In addition, each of these impressions was good enough to serve as an original.

The lithographic institution of the Royal Steuer-Kataster had been in operation for some time when a trivial occurrence had the most important effect on my fate.

It became necessary to print a sheet of such great size that there happened to be no stone in Munich large enough. Weishaupt remembered that he had seen stones in my possession which I had purchased partly for

map-work and partly for printing cotton and tapestries. He sent a printer to me with a letter from Royal Tax Councilor von Badhauser, requesting that I sell the Government a stone of the necessary dimensions. Herr von Badhauser was a friend of my father, and I myself always had entertained the highest respect for him. He was also a friend of Herr Gleissner, and had done many things to oblige him. I embraced the opportunity of doing him a favor with joy, and the matter probably would have had no further consequences, had not Madame Gleissner arrived just as the stone was being taken away.

She suspected that the stone might be desired for a purpose other than the one stated, and sought Herr von Badhauser to ascertain the truth. On this occasion she complained to him that the Government, not content with infringing our franchise by erecting its own printeries, also took away our workmen after I had trained them with much labor and expense.

Herr von Badhauser was surprised. He said that Privy Councilor von Utzschneider had wished to turn work over to me, but that my reply to his proposal, which had been laid before me by a designer named Schiesl, had been that it was against my arrangements to collaborate with any other establishment, and that, on the contrary, it was my intention, with the assistance of Freiherr von Aretin, to press our suit against the Government for infringement.

This Herr Schiesl, a pupil of Herr Methleithner, had worked for us occasionally, and, indeed, was one of the first to use the new process for drawings, especially pen-drawings. As he was rather adept and showed great interest, I gave him full instructions in everything, and he knew all my circumstances exactly. Thus he understood thoroughly that my future depended on the turn that Freiherr von Aretin's affairs might take, and that our situation was precarious, owing to the competition of so many establishments. Therefore, I cannot understand how he came to utter a statement so contrary to the truth.

Madame Gleissner hurried to Herr von Utzschneider and explained my real intentions to him. He promised to consider the matter earnestly.

Herr Professor Schiegg, an excellent geometrician and astronomer, was

member of the Steuer-Kataster-Kommission, and had the supervision over the entire institution. He was not well satisfied. Too many costly proof-prints were being made, and the impressions did not please him. Accidentally he saw my receipt for payment for the stone which I had furnished, and he observed that I did not ask more for it than the Commission had to pay for stones only half as large. Also I charged only twenty-four kreuzer for polishing, whereas the Commission had been paying one gulden for stones of four square feet. He took occasion to represent to the Commission that it might be well to give me the management of the establishment.

Herr von Utzschneider sent for me and asked for a proposition. After discussion with Freiherr von Aretin I proposed that the Commission let me print their etched plates for two kreuzer per impression, in return for which I would pay the workmen, defray the cost of all printing material, and also keep the presses in repair, pull necessary proofs without charge, and bear the cost of all imperfect work.

This plan seemed very fair to me, as the Royal Commission would save two thirds of the expenses it had defrayed hitherto; but it met with such opposition that Herr von Utzschneider advised me to make another proposition, preferably one that involved a good salary for myself and Herr Gleissner, which, probably, would be received with more favor. He added the flattering statement that the Royal Commission would be proud to have me, the inventor of the art, in its employ, and thus to reward my struggles in the name of the fatherland. The excellent man fulfilled the expectations thus raised, and became my greatest benefactor and founder of my fortune; for through him I won the prospect of an unvexed old age, and was placed in a position where I did not need any longer to consider my art merely as a livelihood. Everything useful that I have invented since then, and I hope it is not inconsiderable, is due to the serene and happy position in which I was placed through his goodness.

At the time I thought also that, if we were both employed by the Royal Steuer-Kataster-Kommission, it would save Freiherr von Aretin the burden of supporting us, without causing him damage, as according to the

preliminary promise of the Commission we should have time enough left to manage his institution. So I agreed to assume supervision over the Commission's printery, to give it my best knowledge, and give the workmen complete instructions and training, for which there was to be a salary for life of one thousand five hundred gulden for me and one thousand gulden for my friend Gleissner, with the rank of Royal Inspector of Lithography, and with the right to maintain and conduct our own printery. My terms were graciously accepted, and in October, 1809, we received our appointment.

Only in the beginning were my personal services especially necessary. Later, as the workmen grew equal to their tasks, I found more and more leisure for dedicating myself to inventing improvements. I was rather fortunate in this endeavor, and the various processes invented since 1809 would now be generally known through the publication of many interesting works, had Freiherr von Aretin not been forced to leave Munich to assume his new duties in the Royal Service. This left my art without his assistance, and our partnership reached its end just as it was beginning to attain fruit. My own circumstances did not permit me to continue the establishment on its former scale; therefore, Freiherr von Aretin turned over part of it, especially the art-branches, to von Manlich, the Director of the Royal Gallery, and another part to Herr Zeller. The latter soon gave up the printing business as incompatible with his other interests, but he did a great deal for domestic art and industry later by opening a warehouse for its products, also by publishing a paper and issuing many lithographic art productions.

I kept one or two presses for myself, and as I married the daughter of the Royal Chief Auditor Versch in January, 1810, I hoped to teach my wife to manage a small business. In the very beginning I obtained a large order for passports from the Royal Commission of the Isar, which kept the presses busy for a month. At the same time I contracted with the Royal War Economy Council to furnish all their printing. Besides this, I had many orders from another Royal Commission and from Herr Falter, so that my little establishment was very busy. Unfortunately it happened

that I was not paid at once by the Royal Commission of the Isar, but only after four years. Added to this, after some months I had to support my workmen in idleness for several weeks, because there happened to be no work for them. This gave my wife so ill an idea of the business that she kept at me till I promised her to give up the whole thing.

Madame Gleissner was not so timid. She offered to take over my men if I would turn over to her the government work that I had. At first she did very well, because just then orders came from many directions. She might have made a great success, had her husband not been stricken with paralysis, which rendered him so miserable that at last he lost his mind. Then came the ever-growing competition and at last the government bureau installed its own plant. Her daughter lost her eyesight almost wholly at this time, so that the family fell into a woeful condition, which would be still worse now if they were not sustained by faith in the mercy and grace of our best of kings, who will surely reward their efforts for lithography, which art, according to the belief of all experts, will ever remain a beautiful flower in the shining wreath of the noble Maximilian.

As soon as I did not need any longer to give up my time to earning a mere livelihood, I began seriously to plan publication of my lithographic text-book, the first number of which had appeared previously and been well received. But the skill of the various lithographers made noticeable advances every day, so that I was not content with the specimen pages that had seemed so satisfactory a year earlier. At last I fell under the delusion that it was absolutely vital to my honor that everything that might appear in my text-book must represent the *non plus ultra* of the process. Therefore I decided to suppress the first number entirely, because there were sample pages in it that represented a style which had been done much better since then.

However, many obstacles opposed me. For instance, good artists are very costly, especially if they must learn new methods and practice them. I felt, also, that many of my inventions still demanded many improvements before I could intrust them to the hands of any artists. Still, I hoped finally to accomplish my plan for publishing a splendid work which should

be unique, because I invented improvements and perfections daily. When my dear friend Andre came to Munich in 1811, I laid my project before him and he was so taken with it that he offered his cordial coöperation. We agreed that the work was to be done by Frankfurter artists and printed there. But when I journeyed to Offenbach some months later, I discovered that the right kind of artists were not so easy to find as Andre had led me to hope. Some, who might have been competent, demanded such exorbitant terms that the work would necessarily have been published only at a huge loss. "Copper-etching," said they, "we understand. Stone-etching we must learn. The latter seems to us, who are unpracticed in it, three times as difficult. Therefore it is but fair that we shall be paid three times as much." This sort of reasoning led me to return to Munich to print the work there.

Now two years passed with many experiments. Many a plate was made, printed, and discarded because meantime I had found something better. Then I lost my beloved wife in child-bed, and in my anguish over this loss, irredeemable as I thought at the time, I forgot all my projects till my second wife, a niece of our worthy Choir-Master Ritter von Winter, reconciled me with Providence, notably through her truly motherly behavior toward the son left behind by my first wife. I considered it my duty now to publish my work, that in case of my death their claims to honor should be established. Without this incentive, it would have been much more indifferent to me what men might think of my art or its inventor.

In 1816, Herr Andre came to Munich again, and I imparted to him many of my recent inventions in regard to lithography. On this occasion we decided ultimately which of our plates should be put into the work and which should be discarded. I promised to get seriously to work and we looked forward so confidently to the completion of the entire publication that Herr Andre circulated a preliminary notice of it in the Easter-Messe at Leipsic, whither he went after leaving Munich.

Despite this, there came many delays, the chief one being caused by my meeting Herr Gerold, book-dealer and printer of Vienna, who invited me to establish a printery for him. As my presence in Vienna would be

needed for only three months, I believed that this would cause no delay in the publication of the text-book, because the plates ordered from the Munich artists could be completed during that time, while I could furnish the text as well in Vienna as in Munich. But I had the misfortune of becoming seriously ill soon after reaching Vienna. A great weakness remained as result, and this made it impossible for me to undertake the return voyage in the bad weather that marked the winter of 1816–17.

Lithography did not progress particularly with Herr Gerold during my stay, because he could not obtain the franchise, though he had petitioned for it a year ago. The greatest blame for this was due to Herr Steiner's opposition. This man, who had done but little for the art in the entire time during which he enjoyed the exclusive Austrian franchise that I had turned over to him, did this from pure ill-will, because he had suffered similar ill-luck, as he said.

So Gerold could not establish so complete a printery as I wished, without going into expenses based on an uncertainty. However, various drawings were made that served to show art-lovers what could be done with lithography. It would be easy to perfect this art immensely in Vienna, because there is no lack of excellent artists. Among those who interested themselves at the very beginning in Herr Gerold's undertaking were Herr Colonel von Aurach, Herr Captain Kohl, and Herr Kunike, the drawing-master for the family of Prince von Schwarzenberg. They convinced themselves with many experiments that lithography was eminently suitable for the easy reproduction of many styles of drawing, and recommended the method to all their acquaintances. Through the experiments of Herr Kunike I gained the conviction that one could print true originals by using a method of touching up the impressions.

The crayon method in combination with one or two tint plates is the method that is easiest for the artist to handle. Now this method is very difficult to print, demanding great practice if good, strong, and clear impressions are to be produced. Since there are as yet no complete printeries where an artist can have his own plates printed without danger of damage, there is nothing left except to print them himself, which causes many

imperfect impressions that must be destroyed for the credit of the artist. Herr Kunike had this experience; but he took his imperfect impressions, when they were not entirely spoiled, and worked them over with black crayon. It developed that twelve impressions could be so well touched up by hand that they would fittingly pass as originals, in the time which would be required to copy a single picture properly. As this treatment of illustrations produces their value only by merit of the final finishing, they may be considered as being the same as copies that are made by an artist of his own work, wherein it happens often that the copy turns out better than the original.

Just as I was preparing to leave Vienna I received several numbers of the *Anzeiger für Kunst und Gewerbfleiss*, in which Herr Direktor von Schlichtegroll, General Secretary of the Royal Bavarian Academy of Sciences, had inserted several letters suggesting an inquiry into the invention of lithography. He had used the information obtained from my brothers and from other inhabitants of Munich. On my arrival there I visited him at once to thank him for his patriotic endeavors, and to make some corrections of the story told by him. I had the fortune to win him as a steady friend, who became continually interested in giving my work a greater field.

The completion of this text-book is due to his steadfast encouragement. He furnished me with the opportunity to meet many worthy men and also to demonstrate my many improvements before the Royal Academy of Sciences, the Polytechnical Union, and at last even before their majesties, our most gracious King and his most highly venerated spouse, that illustrious connoisseur and protectress of the arts. Never to be forgotten by me will be the moment when the gracious applause of the royal pair rewarded me for all the exertions of my life. Oh! If only human life were not so limited, if it were granted to me to execute only one tenth part of my designs, I would make myself worthy of this great honor by making many another useful invention! But the time passes swiftly during our helpless wishing and striving; and when twenty or thirty years have been lived, there remains for us only amazement at beholding how little has

been done of all that which glowing imagination and fiery energy painted as being so easy to carry out.

When I saw before me the first successful impressions from a stone, and conceived the plan of making the invention useful for myself, I did not think that it would demand the greatest part of my life. Rather, because it seemed to be a cheap process, I considered it merely a first step toward putting me into a position where I would be able to make inventions far more useful and important. I must, however, count myself fortunate among thousands, because my invention received such thorough recognition during my lifetime, and because I myself was able to bring it to a degree of perfection such as other inventions generally attained only after many years and long after the inventor himself was dead.

Herr von Manlich, the Director of the Royal Gallery, has had his skilled pupils, Strixner and Pilotti, copy many collections in the Royal Drawing Cabinet (Königliche Zeichnungs Kabinett), and many of these sheets are so good that competent critics have declared them to be perfect facsimiles.

But on the whole the publication of the Royal Gallery of Paintings is still more excellent and has aroused general attention, which would be even greater if the printers had been as expert as the artists were. Many of these pages would leave nothing to be desired if the pictures appeared on the paper in perfection equal to the perfection of the drawings on the stone.

The method used for these illustrations is the crayon method, with one or more tint plates. It is the easiest method for the artists because it demands little previous experience. To give it its correct emphasis, however, one must know especially how to get the best effect out of the tint plates. If this is done just right, and if, of course, the drawing bears the impress of a masterly hand, and if the printer understands his art, the impression will be perfectly like an original drawing, so that the most skilled etcher in copper hardly can attain the same effect. Therefore this method, which has the further advantage of being a quick one, is excellently well adapted for copying paintings.

Hereby I wish to express my deepest gratitude publicly to the worthy

Herr Direktor von Manlich and his industrious pupils for the service they have done for the fame of lithography by utilizing my inventions. To their labors, as well as to those of Herr Professor Mitterer, is due the ever-growing sympathy and interest of the public.

Herr Mitterer now has attained such perfection, especially in the simple crayon method, that many of his productions probably will remain the *non plus ultra* of this method. Lithography also owes to his unresting energy the triumph of having been become the mother of many useful works of instruction, which are so cheap that they only require the active work of a good art-dealer or book-dealer to become widely circulated.

Besides this, Herr Mitterer is the inventor of the so-called cylinder or pilot-wheel press, which he has improved so much lately that it does almost everything that one can demand from a perfect press in point of power, speed, and ease of operation.

Since 1809, I have dedicated myself almost uninterruptedly to improvements, and to the work of reducing all manipulation and processes in all branches to their simple elementary principles. Thus some of my earlier inventions — such as transfers from paper which has been inscribed with fatty inks, and the transfers from new and old books and copper-plate impressions — have been brought to a high degree of excellence through my manifold experiments, so that one can make lithographic stereotypes in the easiest manner.

Furthermore I have made such progress in color printing that, besides pictures illuminated with colors, I can also produce pictures quite similar to oil paintings, so that nobody can discover that they have been printed, because they possess all the distinguishing points of paintings.

At the same time I have invented a new method for printing pictures, wall tapestry, playing-cards, and even cotton, which enables two men to make two thousand impressions of the size of a sheet of letter-paper daily, even though the picture may contain a hundred or more colors. Incredible as this may seem, I surely shall produce extraordinary and amazing proofs of this in a few years if I remain alive and well.

Among the other methods that I have invented since this time the most

excellent are some aqua tint processes, the spatter-work method, the intaglio crayon method, the conversion of the relief method into intaglio and vice versa, and the machine-written text for editions de luxe.

Among other things I also sought to remedy the difficulty which arises from the great dependence on the skill and industry of the printers. Therefore I planned a printing-machine wherein the dampening and inking of the stones should be done not by hands but by the mechanism of the press itself, which, in addition, could be operated by water and thus work almost without human intervention. With this invention I believed that I had set my art on the pinnacle of completion; and when in 1817 I exhibited a model of this press (which also was adapted by me for utilizing the principles of stone or chemical printing on metal plates) before the Royal Academy of Sciences in Munich, I was so fortunate as to receive its golden medal in sign of universal approval.

But the most important of all my inventions since my employment in the service of the Royal Government was, without question, the invention of a sufficient substitute for the natural limestone plates, which often incurred well-founded censure because of their unevenness, weight, and fragility, and have the further fault of demanding a great deal of storage room.

Before the Royal Academy of Sciences, and also before the Polytechnical Society of Bavaria, I demonstrated that chemical printing could be utilized with advantage on metal plates; but that still more useful was a composition of artificial stone which could be painted on metal, wood, stone, and even on plain paper or linen, and used in all processes exactly like the natural Solenhofen stone.

The countless experiments that I have made in the past four years with this substitute (or, as some call it, stone-paper), in order to prove its usefulness under all circumstances, have filled me with the absolute conviction that it replaces the natural stone completely without having the many faults that in the nature of the case are inseparable from the use of the latter. In many respects it is far superior. The fragility of the Solenhofen stone requires the use of thick slabs for printing. If the impression is to be letter-sheet size, the stone must be at least one and one half inches thick if

it is not to crack under pressure. If the stone is to be used for more than one job, the thickness must be two to three inches. To be sure, it can be ground and used over again some hundreds of times, a valuable consideration in view of the capital invested in a stone. But such a stone weighs from sixty to eighty pounds, sometimes more, and occupies considerable space. Add the investment necessary for laying in any great number of stones, and it becomes a difficult matter financially to undertake work that requires that the stones be held for a number of years, to be used for new impressions according to the sales of the work. Therefore it is necessary, generally, to print a maximum quantity at once, so that the stones may be ground and used for new work.

If the stones are of thickness correctly proportioned to their area, the danger of cracking under the press is fairly remote; still, it does happen occasionally that a stone incurs damage through clumsiness of workmen. It can occur also through careless warming, or through sharp frost. In such cases even a strong stone will crack, especially if the workmen apply undue pressure.

Besides, the necessary stones are not to be found in all places, so that the cost of transportation prevents the establishment of lithographic shops in many regions.

All these objections are overcome by the invention of stone-paper. The material advantages of it are as follows: (1) The cost is much smaller than that of a stone of equal size. (2) The weight is inconsiderable; a plate of letter-sheet size weighs scarcely four ounces. (3) Hundreds of such plates piled on each other require scarcely as much space as a single stone, and can, therefore, be stored or shipped easily. (4) They resist the most powerful press better than do stone, copper, and even iron plates. Their inner elasticity supports the most extreme pressure without alteration if only they are handled properly. (5) The application of fatty inks, and also engraving with the steel graver is easier. Indeed, because of the great toughness of the stone-paper, the engraving process approaches copper engraving more closely. (6) Inking and printing are easier, and demand no such powerful pressure, because the artificial stone receives and imparts

color more readily, than does the natural stone. (7) Finally, they are so excellent for all methods of printing that it is possible to reproduce the original plates at will merely by transferring a fresh imprint to another plate. And this can be done with such accuracy that none of these plates can be distinguished from the original, so that the stone-paper surely must become of enormous importance for stereotyping in the book-printing trade.

These advantages, and others to be described on suitable occasion, elevate this invention unquestionably to the highest importance in the art of chemical printing, despite all that may have been said recently by a certain writer whose lack of knowledge forbade correct judgment. The matter already has attained a degree of perfection that makes every further improvement unnecessary, nay, almost impossible.

My many employments, mostly caused by the publication of this textbook, thus far have prevented the erection of my own manufactory for making these artificial stone-plates or stone-paper. I hope to do it soon, and then everybody can convince himself of the truth of my assertions, if he will use the material according to my instructions.

This invention will facilitate the introduction of lithography in all places, because one can make the stones himself. However, lithography has expanded very considerably in its present form, and has been brought into use in the foremost cities of Europe. For instance, it was introduced into France and England, first by Herr Andre, in latter days by the Count von Lasterie in Paris and Herr Ackermann in London, being utilized for many kinds of printed work. In Berlin, Herr Major von Reiche has erected a great institution. In Petersburg the art has existed for some years, and is being especially well cultivated now by Freiherr von Schilling. The art has entered even Philadelphia, and, more extraordinarily, Astrakan, and, so far as I can learn, has been welcomed heartily.

I desire that soon it shall be spread over the whole world, bringing much good to humanity through many excellent productions, and that it may work toward man's greater culture, but never be misused for evil purposes. This grant the Almighty! Then may the hour be blessed in which I invented it!

SECTION II

TEXT-BOOK OF PRINTING FROM THE STONE

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to which belong —

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INTRODUCTION

PRINTING from stone is a branch of a new process, different in fundamental principle from all others, namely, the chemical process.

Heretofore there have been two leading printing processes for manifolding writings and drawings, one working with characters in relief, the other with sunken characters.

Of the first kind is the ordinary book-printing, in which the characters are made of metal or wood in such form that only those lines and points are elevated that are to take color, everything else being depressed. The wooden forms for cotton-printing are made thus also.

Of the second kind are all copper and zinc plates, and the cotton-print process with copper plates or cylinders. In this method the lines and points to be printed are depressed, being either engraved, etched, or stamped.

As is well known, the first method of printing is as follows: The letters, which are all at the same elevation and, therefore, furnish a plane surface, are inked with a leather ball, stuffed with horsehair. As the ball is so firm and elastic that it can touch only the elevated parts, these alone can take the color, which adheres because of its sticky nature. The same is true of the carved wood used in cotton-printing, with only the difference that, instead of rubbing with a leather ball, the wooden plate itself is laid on a cushion covered with the color, and then, being placed face down on the cloth, is hammered gently to produce the imprint.

In copper and zinc printing the method is reversed. In order to force the color into the depressed parts, which alone are to be printed, the entire plate is coated with color, and then the elevated surface is cleansed again carefully. The cleaning rag cannot reach the depressed grooves, so that more or less color adheres to these according to their various depths.

Under the powerful press, which forces the paper into all the engraved parts, this color transfers itself and thus gives the desired impression.

It is evident that both methods rest on purely mechanical principles: book-printing being based on the fact that the color adheres only on those places that it can reach, and copper-plate printing depending on the fact that the color remains only in those places from which it cannot be removed by cleansing.

It is different with the chemical print. This does not depend on either elevation or depression of the design. It depends on the fact that the design is coated with a preparation of such nature that afterward the printing color, which is made from a related substance, adheres because of its chemical similarity; and furthermore, because all parts of the plate that are to remain white, have been so treated that they repel the color. These two purely chemical objects are attained fully with the new process. Daily experience proves that all fatty bodies, such as oil, butter, tallow, fish oils, etc., and all such as easily dissolve in oil, like wax, resin, etc., refuse to unite with any watery substance without the aid of some third body that will bring about such union. The chief solvent for this purpose is alkali, which, under proper manipulation, always produces a sort of soap that then is soluble in water. Sometimes, to be sure, an apparent union can be produced by violent shaking or mixing, without the use of the alkali, but at the first opportunity the fatty substances separate themselves again from the watery ones.

It is on this fact that the entire method of the new process is based. It is termed chemical printing with perfect propriety, as the reason why a fatty color, say, linseed oil varnish, will adhere only on the designed parts of the plate and is repelled by the rest of the surface, is due to the chemical properties of the materials.

It might be maintained that in the other forms of printing, color adheres from the same reason. This is true, to be sure; for it is a general law that water and oil will adhere to all bodies that are dry. But it is not the case with these fluids mutually; and in this fact lies the unique difference between the older and the new processes. A dry plate would take

color over its entire surface. If, however, it is dampened, it will take oil color only on those places that are in a condition opposite to dampness. Therefore, the repelling of the color from those parts that are to remain white is the novelty.

It must not be imagined, however, that to print chemically it suffices to dampen certain parts of the plate and to coat others with fatty substance. With most of the materials available for printing, mere water does not suffice to produce a sufficiently repelling obstacle between the plate and the color.

With flinty and clayey bodies, — for example, glass, porcelain, slate, etc., — one can manage with mere water; but then the slight adherence of the fatty color to the plate produces an opposite difficulty, by preventing any large number of impressions. Still, by using very firm and readily drying fatty substances, such as linseed oil varnish dried with litharge of silver it is possible, in case of need, to succeed fairly well.

But with such bodies as attract the color powerfully, such as all metals, wood, limestone, artificial stone-paper, etc., it is necessary so to treat all the parts of the plate that are to remain white that they attain an especial resistance to color, and thus change their natures, so to speak.

That this is possible under certain circumstances and with the proper means, with all bodies belonging to this class, I have proved by many experiments, and I shall describe the methods in this book.

Thus the new process is not to be used only on limestone, but is applicable to metal, etc.; and stone-printing or lithography is to be considered only as a branch of general chemical printing. However, as this book is to teach mainly lithography, I will occupy myself chiefly with it.

Among the bodies available for chemical printing, limestone maintains an eminent place. Not only has it an especial property of uniting with fats, — sucking them in and holding them, — but it has, also, the same propensity for taking all fluids that repel fats. Indeed, its surface unites so thoroughly with many of the latter that it forms a chemical union with them, becoming practically impenetrable for oil colors and remaining constant thereafter in repelling them so that they cannot adhere per-

fectly. Therefore when a plate thus prepared is dry and covered entirely with oil color, it still remains an easy matter to wash it completely, using merely water for the purpose.

This good property, combined with the low cost and the ease of obtaining the stone in Bavaria; then the advantage that it is easily polished and prepared; the further advantage that a stone of medium thickness can be ground as often as a hundred times and utilized for new work—all these properties combined made me willing to overlook a few faults, such as their weight, great volume, frequent unevenness of quality, and lastly the occasional danger of cracking. Thus I came to use these stones as the principal means for making my countless experiments, whose happy result has been to elevate stone-printing to an art by itself.

Having stated the process and the character of this form of printing, it remains only to say a few words about its value.

With every new invention there arises the question if it is useful, and if so, in how far, for science, arts, and industry. Therefore all who have no sufficient knowledge of lithography, will ask justly: What is its value? What advantages does it give that are not to be found in any other forms of printing?

To answer this, let me say the following merely in advance till later descriptions of the various processes will convince in themselves.

It is the nature of earthly being and of human imperfection that rarely is anything found that combines in itself everything to be wished for and required. So it may be said of stone-printing that it makes neither book-printing nor copper-plate printing entirely superfluous. It is possible that in the future, by perfecting the presses, lithography may equal book-printing in point of speed, as it does not now; but the convenience of the latter, enabling the printer, by merely setting cast characters side by side, to do with speed, accuracy, and symmetry what the writer can hardly do with all his skill and industry, gives book-printing its own eminent value. When, however, we come to many things produced hitherto by book-printing, such as statistical tables, letters, circulars, letters of exchange, bills of lading, visiting-cards and addresses, and

other similar work, we find that these can be produced more conveniently, more readily, more cheaply, and faster and handsomer with lithography.

As to copper-printing: in the future, as lithography extends, there probably will remain an advantage with the copper in the case of only two styles, the engraving done with the engraving needle, and the etching, the latter being worked up with the graver and the cold needle. In this respect, however, the skill of the artist must be taken into account, for a good man can produce better work on stone, even in those two styles, than a less skillful man can produce on copper. We can declare the same of the stipple style in copper, when done in the style of Herr Bartolozzi, or even like the very foremost of the copper engravers in this style, Herr John of Vienna.

All other methods (and even these three if done with less care or skill on copper) must yield place to a good design on stone; especially if one takes into account the ease of execution, the lesser need for skill, the greater speed of printing, and the almost countless impressions that are possible.

For instance, printing music from the stone has a decided advantage over zinc plates, both because of smaller cost and greater beauty. It is easier to produce all kinds of script on stone, both with fatty inks and with the engraving needle. Therefore lithography serves excellently for charts and similar work, which can be done at least three times faster on stone than on copper.

If copper-printing is to reach a high degree of perfection, the printing itself must be done by very excellent workmen. Indeed, some persons allege that the very best German copper-plate printers do not yet equal the Parisians. Printing from stone is not so difficult, and only a few particular methods demand especial care or unusual knowledge. Because of the greater ease of inking, the speed of stone-printing may be assumed to be at least five times as great, often ten times, and especially so when large plates are to be printed. Besides, it is much easier to make corrections on stone than on copper and zinc.

From all this it appears that lithography makes it much easier to write and design and then to print swiftly and produce any desired number of impressions, of all those works that heretofore could be produced only on copper or zinc, providing they do not demand the very greatest degree of delicacy, strength, and sharpness obtainable with copper; in a word, so long as it is not vital to attain the utmost possible artistic beauty. Further, most of these works done on stone, by only average artists and printers, usually are more beautiful than if they had been done by the same men in copper or zinc.

This property alone gives lithography a preëminent value, the more so as no great expense is incurred in establishing a plant. But in addition to this, there are several art methods peculiar to it, which cannot be imitated by book-printing or copper-print, and which make it possible for almost every writer or artist to manifold his works without any especial skill.

I will mention now only the crayon process, which enables every artist or painter to make several thousand impressions of his original drawings; also the transfer method, by means of which all that is written or drawn with fatty ink on ordinary paper can be transferred to the stone, giving countless faithful impressions. This latter process is particularly useful for government bureaus, and is being used already with great profit.

All this I believe that I can claim for lithography with fullest confidence, and I hope that everybody who becomes sufficiently conversant with it will share my belief. Thus, besides the properties of the art, we have stated its uses, and I proceed to the real instructions, through which I hope to make good artists and printers on stone.

PART I

GENERAL PROVISIONS

CHAPTER I

OF THE STONES

I

THE stone that has been used exclusively hitherto in Munich for printing is a stratified limestone, found in the territory from Dietfurt to Pappenheim, and along the Danube down to Kellheim; hence the name Kellheimer plates, presumably because in past times the stone was quarried there first, or else found in its best quality. Now the Kellheimer quarry is exhausted, and the trade in the stones has transferred itself to Solenhofen, a village in the judicial district of Mannheim, three hours distant from Neuberg-on-the-Danube. All the inhabitants of Solenhofen are quarrymen, and the entire surrounding country seems to have a surplus of the stone, so that even with the greatest demand no scarcity is to be feared for centuries.

When the upper layer of earth is removed to the depth of six to ten feet in Solenhofen, the stones are found in strata lying horizontally on each other. First come strata of brittle stone, which often are composed of hundreds of plates as thin as paper. With proper care, each plate can be loosened and lifted whole. These layers are useless, being too brittle, and yet being too firm and not white enough to permit their possible use as chalk.

The Solenhofen stone consists chemically mostly of lime earth and carbonate. It is almost wholly soluble in nitric and other acids, the carbonate being liberated in gaseous form and disappearing. Since the various kinds of marble have almost the same component parts, one might sup-

pose that marble should be available for lithography. But the many dark, uneven colors of marble and chiefly the many cracks and veins make considerable difficulty. However, I have found many evenly colored greenish, gray, bluish, and brownish Bavarian and Tyrolean marbles very useful for some methods, especially because of their superior hardness. Still, the Solenhofen stone will retain the advantage because of its light color and its greater cheapness.

The white Parian or Carrara marble is still lighter in color, to be sure, and really is rather useful for pen and crayon work. But though in part it is harder, on the whole it is much more porous and not so finely grained as the Solenhofen stone, and therefore not at all available for the intaglio method.

Since lithography began to arouse general interest, there have been attempts to find a stone similar to the Solenhofen, and there has been some fair success in France, Italy, England, and lately in the Kingdom of Prussia. With the enormous masses of limestone which cover the surface of the earth, it is not unlikely that this stone will be found in many places, either in layers of plates one, two , or more inches thick, or in great blocks which can be cut into plates.

In the Solenhofen stones one layer is not as good as another, and even in the same layer there may be a decided difference. Therefore, if one would produce perfectly beautiful work, it is necessary to obtain selected and perfect stones. This should be stipulated beforehand with the quarrymen, who now know pretty well how the best stones should be constituted.

A good stone must have the following properties: —

(1) *The proper thickness.* Thickness must be proportionate to the size. Smaller plates will resist the pressure of printing even if they are not so thick as the larger ones must be. But it is best to buy no stone less than one and one half or more than three and one half inches thick, because the thinner ones will not bear frequent grinding and the thicker ones are too heavy and inconvenient, besides taking up too much room. The best thickness of a stone is two to two and one half inches.

(2) *Good mass.* There are soft and hard stones. Sometimes the same stone is hard above and soft underneath, or the reverse. Often, also, a stone may consist of several thin and unequal layers. In the latter case, if the union is good and the layers are not easily separated, it will make no difference, so long as the stone is good in other respects. On the whole, however, it may be assumed that the harder stones are the best for all methods, so long as their mass is entirely uniform and they are not marred, as is the case with many, with white dots and patches. Then, to be sure, they are not worth much for any process, and at best can be used only for pen designs or for such of the intaglio processes where the lines need no particular sharpness. Such stones, generally gray, very hard, with softer, somewhat lighter patches or specks, are very hard to grind evenly because the softer parts are most powerfully attacked by the grinding material and become depressed. This produces the following defects: —

(*a*) In pen work, the pen will catch often, whenever it comes to such a place. This, however, is not so important: but

(*b*) In the crayon method there will be defects and lights in the shadings on the softer places, which are very hard to correct.

(*c*) In the etched or engraved methods, the needle will sink in much deeper when it passes over such softer spots, making a deeper and broader line which injures the clearness of the drawing. In etching, also, the softer places are more affected by the acid; and it is better, therefore, to use a soft stone whose entire surface is uniform, than to have a stone that is hard but uneven.

A very soft stone cracks easily in the press, unless it consists of several layers, the lower of which are hard. But it is easier to engrave, and as a rule gives blacker impressions, because it sucks more color in, and holds it because of its greater porosity. Printing, however, is somewhat more difficult, because these stones take dirt readily; nor is it possible to get so many impressions. They are not useful for crayon work because the finest shadings are too easily etched away; and pen work is difficult on them, because the steel pen easily cuts into the stone, fills its point with fine dust, and thus gives no ink flow. This softest stone in Solenhofen

generally looks yellow, or is marbled with red and white or has many yellow veins.

Even those stones whose uniformity, thickness, and hardness make them best for all methods, often have defects, such as so-called glass spots or tiny, sometimes invisible holes, broad veins and cracks. All these must be avoided when selecting stone. Very small deep veins, which often are fine as hairs, yellowish and grayish spots, impressions of fossil plants and fishes, etc., are not harmful. It is rare to find a stone as large as a sheet of note-paper that is entirely free from these little defects.

(3) The form of the stones also is to be considered, and must be selected according to need. To be sure, a small design can be drawn on a large stone; but apart from the inconvenience, the construction of the press demands that the stone be not much larger than the drawing. However, at the end where the impression begins and stops, there must be at least an inch margin to give sufficient room for the roller to take hold, as will be explained more particularly later.

When one has to print small things like visiting-cards, etc., it will not be profitable to use large stones, especially if they are to be saved for future use. Small stones of the size of an octavo sheet are better. Therefore it will be wise to have stones cut to various sizes in the beginning. It would be well also that one of the printers, or the polisher, strive to attain skill in cutting stones to size. Sometimes polishing discloses defects in a stone, making it useless for a design of any size. But it is possible to cut it up into many small ones that are perfect. Sometimes a stone cracks under the press or breaks through accident. Skill in cutting will enable one to make small and good stones out of the pieces.

It is essential for good work in the press that the stones be cut very true. The stones that are used for flooring in churches, etc., usually are cut so that the upper face is larger than the lower. This is done to make them set better in the mortar and to enable the stone-cutters to fit them closely together on the top. But this must not be done with stones for printing, because such stones could not be tightened properly in the press and would lift during the printing. Printing-stones must be cut

absolutely true vertically. Indeed, in work where several plates are to be used to make one complete impression, and where steel guide-points in the frame are used instead of laying the paper on the plate, it is beneficial to cut the stones conically, so that the base is one fourth inch greater than the top. The plate can be tightened better and is less likely to be moved from its place during the impressions.

Despite their hardness the stones are brittle, and a single light but sudden blow with any hard body, such as a steel tool, may cause a crack in the thickest stone. It is necessary to exercise great care to avoid all shocks.

This property of the stone is used in Solenhofen to cut the stones according to desire. A small hammer of hard steel, weighing scarcely two ounces, is used. Its end is somewhat like a stone-chisel, but not nearly so sharp. With this hammer, which is set on a thin handle two or three feet long, the workman strikes light but very swift blows along the line of desired cleavage, each tap being about an inch from the preceding one. The stone is so laid that its greater part is free, resting on nothing. This light operation is sufficient to cleave the largest stones.

The cleavage is not always uniform and true. Therefore the stone usually is finished with a sharp stone-chisel. It is possible also to divide a stone as desired by supporting it at both ends so that there is nothing under the part to be split, and then cutting along the line with a chisel of hardened steel, not too sharp, which is tapped lightly with a light hammer. The varying sound tells at once when the stone cracks, and then a few light taps with the hammer on the other side suffice to separate it. Before one attains the necessary skill, however, he will smash many a stone. Therefore it is not advisable to try this on a stone that has a design on it, for a single incorrect or over-heavy blow often will split the stone in the wrong direction. Blows that are too light, on the other hand, often make it almost impossible in the end to cause a cleavage along the desired lines.

II

POLISHING

The stone plates that come from Solenhofen, even if polished according to stipulations, rarely are available for printing, but must be specially polished by one who understands the work thoroughly.

The first requisite for this is a straightedge of iron or brass, as true as possible. This ruler must be laid on the stone in various directions, and the lithographer must note all parts where there is space between the straightedge and the stone. The greater the space, the greater the unevenness of the stone; and those that show especial unevenness should be set aside from those that have little.

When this has been done, the very uneven stones must be ground with a coarse sandstone and plenty of water applied to the elevated places till the straightedge can be applied in all directions without showing any material interstices. Then these ground stones may be placed with the others that were fairly even in the beginning.

Now we take one of these stones, and lay it on a strong, firm table, the best being one to be described later. Finely grained sand is sprinkled over its surface. In the absence of sand, a substitute can be made by powdering a common sandstone of the kind used for coarse grindstones. A spoonful of water is poured over this. A little soap may be mixed with the sand. It facilitates the grinding and makes the sand take hold of the stone better. Now another stone is laid on the first one, and is moved back and forth continually in all directions. The sand and water must be renewed often. Thus both stones, the upper and lower, will be ground simultaneously, and very evenly and true, if the work is done right.

One must take care never to draw the upper stone far beyond the lower one, because that would throw the centre of gravity of the upper plate too near its ends, as a result of which the upper plate would become concave and the lower plate convex. To avoid this defect, the upper plate should be moved around only in small circles. It is good also to change the plates around frequently, so that the upper shall be the lower. An-

other good plan is not to use two stones of equal size, but to take for the upper stone one only half as large as the lower. It is necessary also that the straightedge be applied frequently. The stone must always be cleansed thoroughly before this test.

Once one has the proper experience, it is possible to tell by mere touch if the plates have been sufficiently ground. So long as they still have uneven spots, a certain resistance is noticeable, so strongly sometimes that it is impossible to move the upper plate further without lifting it and sprinkling new sand. Sometimes this friction is so great that manual strength does not suffice to separate the stones, especially if they happen to dry. If tools are used to separate them, it happens often that pieces are torn from the stones, because they adhere so mightily. In this case a very simple and convenient remedy is the best. An ordinary table-knife is inserted gently and then tapped very lightly, when the stones will separate at once.

Whenever sand is applied, water must be applied also, but not too much, as in that case it would only wash away the sand. Here, too, practice must teach the exact proportions.

From the stone-cutter's work, as well as from the primary grinding with sandstone, the plates will have visible furrows and scratches made by the coarser grains of sand. Under the polishing all these disappear bit by bit, and there appears a fine grain, consisting entirely of fine dots; and this is the finer in proportion as the sand is crushed by the process of polishing and also according as less fresh sand has been used.

When the marks of the sand have vanished completely, it is fairly certain that the stones are polished sufficiently. To make sure, the straightedge can be applied again. It must not be imagined, however, that it is necessary or possible to polish a plate so perfectly that there will be absolutely no spaces between any part of its surface and the straightedge. A perfect and mathematically level plane surface is hardly likely ever to be produced. If the stone is almost level, and the unevennesses do not exceed the thickness of letter-paper, it is quite sufficient.

Although this sort of polishing, with two plates at once, is not used

in all lithographies, some preferring to polish with small pieces of sandstone, I give it here as the best, because it demands little skill and is quicker, so that one can grind off four stones in the time required for one under other methods.

In this matter of smoothness of the stone it is impossible to be too careful. The beauty of the imprint depends upon it. Errors in the polishing cause great trouble afterward. Therefore the manager of a lithography must pay close attention to this work. In the Lithographic Institute in Berlin the rule has been adopted that no engraver shall accept a plate that he has not found thoroughly good, under penalty of reimbursing the printers for all extra trouble and work.

This first polishing, however, is only the general preparation of the stone. Afterward they must be polished and prepared especially for each particular method, as will be explained in the proper place.

III

SORTING AND STORING

When the plates have been polished, they are cleansed with water and sorted for their various uses. Now it is easier to see just what quality the stones have, their defects, and consequently, what work they are best for. Those not uniform are best for coarse pen work. Those of uneven coloring, but hard and thick mass, can be used for the finer pen drawings, for etching and engraving, or for transfer work. For crayon work the clearest and most evenly colored stones of extreme hardness are to be selected.

They can be stored anywhere that is not too damp and not too much exposed to winter cold. Dry cold does not hurt them; but if they are wet through and through and then freeze, they will crack. In constant dampness, too, saltpetre and other salts enter them and they crumble. In clean water they do not undergo any changes.

I will describe the storage of etched and designed stones later.

If the stones are to be used after being stored in any damp place, they

should be kept for several days in a temperate and dry place till they have dried thoroughly, as otherwise they are not easy to work in any style. This is not necessary if their place of storage has been perfectly dry.

CHAPTER II

OF INK, CRAYON, ETCHING, AND COLOR

I

CHEMICAL INK

THE first and most necessary material in a stone printery is the so-called chemical ink, which would better be named fatty or alkaline ink, since it is a mixture of fatty and resinous materials with alkali. It is used partly to write or draw directly on the stone, partly to cover the stone as with an etching surface, and partly to transfer to the stone from paper.

The purpose of this ink is, first, to cause a mass of oily, fatty substances to soak into the pores of the stone and also make certain portions of its surface fatty; and secondly, to resist acids according to requirement in such degree that the stone shall remain fat where needed, that thus the design, applied with this ink, shall be left untouched by acid.

I have remarked before that countless different mixtures can be made, most of which fulfill the purpose. But there enters the consideration that it must be an ink easy to use, that handsome work may be done by the artists with perfect ease.

Various mixtures answer this purpose very well, and I have found sometimes that men could work better with mixtures made by themselves than they could with those that I used for my own work. Perhaps this was a matter of imagination, or the real reason lay in the pen-cutting, it being well known that one man can use a pen that is absolutely worthless for another.

I myself have tested the values of some mixtures so thoroughly that I

can declare almost positively that it will not be easy to find better ones for any purposes. I will describe these fully.

First of all, stone-ink is divided into two great classes. One is thicker, being used for drawing on stone. The other is more fluid, being used for transfers.

The following mixtures of the first kind are the best:—

(1)	White Wax	8 parts
	Soap	2 parts
	Lampblack	1 part

This ink does not really serve for writing or drawing on the stone, but is used mostly for coating those places that are to be protected from the etching fluid. If this ink is needed in a thickened form, the wax should be heated in an iron pan till it burns and the combustion should continue till one half of it is consumed. The longer it burns, the harder will be the remnant.

(2)	White Wax	12 parts
	Tallow (Ox Fats)	4 parts
	Soap	4 parts
	Lampblack	1 part
(3)	Wax	12 parts
	Shellac	4 parts
	Soap	4 parts
	Lampblack	1 part
(4)	Tallow	8 parts
	Shellac	8 parts
	Soap	4 parts
	Lampblack	1 part
(5)	Wax	8 parts
	Shellac	4 parts
	Mastic	4 parts
	Soap	4 parts
	Lampblack	1 part
(6)	Wax	8 parts
	Tallow	4 parts

	Shellac	4 parts
	Soap	4 parts
	Lampblack	1 part
(7)	Wax and Gum quajak	12 parts
	Tallow	4 parts
	Soap	4 parts
	Lampblack	1 part

The wax and gum are melted in equal proportions, the undissolved portion is discarded and of the mixture twelve parts is used as above.

(8)	Wax	6 parts
	Shellac	4 parts
	Tallow	2 parts
	Mastic	3 parts
	Venetian turpentine	1 part
	Soap	4 parts
	Lampblack	1 part

There is no important difference between the inks in the seven last formulas. Those that contain shellac remain fluid a little longer but are harder to prepare. It is not necessary to be painfully minute about the proportions of the various materials, providing the proportions of soap and lampblack be correct. The soap is about one fifth and the lampblack about one twentieth part of the whole. If too much soap is used, the ink will dissolve more readily, but the solution will become slimy more quickly. Too much lampblack would make the ink run.

MAKING THE CHEMICAL INK

In making any of the inks mentioned, first divide the required quantity of soap into two equal parts. Put one part into an iron pan with the other substances, and heat till the mass begins to burn. Let it burn till almost one half is consumed. Then cover the pan with an iron lid, or place it very carefully into a basin of water to extinguish and cool the mixture.

One part of the soap is mixed in at once, that the combustion may make it mix well with the other substances. But it loses some of its strength and sates itself with carbonic acid, so that it is not quite so powerful as before to attack the fats. Therefore a second part is added after the combustion. Then the complete mixture is heated again, but only to a degree sufficient to melt the soap.

Now take up a bit of the mass with a clean knife and see if it is easily soluble in river or rain water. If the soap was good (something not always the case), the quantity named in the formulas always suffices. If it does not contain enough alkali, little pieces of soap must be added till the mass is soluble. Then the lampblack is added while the mass is being stirred without cessation.

The lampblack must be of the finest sort, and should be roasted and burned in a closed vessel until it ceases to give off any yellow smoke.

When everything has been stirred till the mass is nearly cold, it is kneaded into any desired shape, sticks being the best, and so saved for use.

The following remarks are to be noted especially: —

(1) The soap is to be the ordinary soap made from ox fat and lye. In the formulas its weight is calculated in fresh form, which, of course, includes considerable water. If the soap is very dry, less must be used.

Venetian or vegetable oil soap is not so good because the ink easily becomes slimy afterward when dissolved in water. It does not resist acids so well, either. If, however, the other kind is not to be had, or to be had only in poor quality, the Venetian soap will do. It will be necessary merely to make frequent fresh solutions in water of the ink.

(2) Lampblack is not the only substance available for giving color to the ink. Vermilion, red chalk, indigo, blue lake of logwood, and several other colors can be used, so long as they do not consist of acids or other salts, and thus have properties that could alter the nature of the soap. The finer kinds of ordinary lampblack can be used without burning, but then a part of the soap always is rendered inactive, because the lampblack usually contains a considerable quantity of inflammable wood acid

which unites with the alkali, neutralizes it, and thus destroys its effectiveness against fats. Therefore, if it is not roasted beforehand, it may be necessary to mix more soap with the ink after it is made, and this does not completely remedy the trouble. Lampblack can be purified by rubbing down with strong lye and then boiling in sufficient water till no trace of alkali remains, if roasting and burning be undesirable for any reason.

Better even than this purified lampblack is one that one makes for himself from ox or other animal fat, from wax, or better still, from a mixture of ox fat and resin. The fat is melted and poured into an earthen lamp similar to those used for city lighting, with a cotton wick. The lamp is lit and placed under a plate of iron or brass, so that the smoke must settle on it. The plate must be close to the flame. The soot is scraped off from time to time and dropped into a glass, which is kept covered. This process continues, the lamp being refilled till one has the desired quantity. This soot is very fine and bland, and so good that one can do more with an ounce of it than with three ounces of the ordinary kind. The ink made from it is extraordinarily fine and good.

It is to be noted in conclusion that the more soot is used, the blacker will be the ink, but the coarser will be the work, because the ink will have the tendency to spread. The less soot is used, the finer will be the work; but it is not easy then to see what one is doing or to judge if the design is strong enough. The quantities given in the formulas appear to me to be the best, especially if the self-manufactured soot is used.

(3) To dissolve the ink, rain water or pure soft river water is best. The rain water must not be very old or stale, otherwise the solution will get slimy.

(4) The severe combustion is not vital for making the ink, but helps very much in making it easy to use.

(5) When shellac is part of the mixture, it is vital to burn the mass well, as only thus will shellac dissolve properly.

Shellac, which is made in China and East India from an insect belonging to the bee family, will melt under moderate heat, but will not dissolve in any animal fat or oil unless it has previously lost its inherent acid,

which occurs only under combustion. If shellac is melted with oil or fat, it covers the bottom of the vessel in the beginning. With heat increased till it causes combustion, it begins to swell, rises to the surface, and at last covers the surface in the form of a spongy mass. If the heat still increases, it begins to dissolve into foam. Then it is time to remove the mass from the fire and to cover it with a tight lid, that the flame may be extinguished.

If shellac has been once melted and has hardened, it dissolves only slowly even under severe combustion. It is better, therefore, to bring the other substances to combustion first, and then to mix the shellac in small portions, which will dissolve much more readily because they will be attacked by the great heat in the moment of melting and will not have time to swell first and get hard.

As soon as the mass has cooled a little, the second part of soap is added, and the whole heated, without burning, merely enough to melt the soap.

(6) None of these mixtures can be kept well any length of time in fluid form, that is, dissolved in water, because it becomes slimy after a very few days, sometimes sooner. It can be liquefied again by mixing with water, but not without affecting its durability. Therefore the ink must be stored dry, in which form it lasts for years without change. When required, a small quantity, about the size of two peas, is rubbed down in a very clean small earthen or porcelain vessel, such as a saucer. Those mixtures that contain tallow rub the easiest. The others, containing harder substances, require more pressure. The ink should be spread evenly over the bottom of the vessel. Then a coffee-spoonful of rain or other soft water is poured in, and the mixture is rubbed with the finger till the solution is perfect. Then it is put into a small, very clean pot of glass or porcelain and is ready for use.

(7) A great deal depends on the proper quantity of water. A good ink must be completely dissolved, with no solid particles left. It should be about as fluid as a good, fat milk or vegetable oil. If it is too thick, it makes the work difficult. If it is too thin, it will not withstand the etch-

ing fluid. A few experiments will teach the proper proportions. Even a good ink will make poor lines if it is laid on too thinly and not firmly enough. This, however, is due to the artist's lack of skill or to defective pens, of which I will treat hereafter.

With this quantity of ink it is possible to work for a whole day. Thus each day fresh ink can be mixed; and it is to be noted that the vessels must be cleansed scrupulously that no trace of the previous day's ink be left in them. The ink will dry during the work, and as soon as this begins to interfere with its use, one or two drops of water will thin it again sufficiently.

This is about all that need be said about the chemical fatty or alkaline stone-ink in general. Particular remarks will be found in the description of its use for particular methods.

II

HARD BORAX INK

Besides the inks described, it is well to make the following and keep it in stock for uses whose great value will be explained later.

Shellac	4 parts
Borax	1 part
Water	16 parts

Borax and shellac must be put into a clean pot filled two thirds with water and boiled for an hour. As the water boils away it must be replaced. When the shellac has been mostly dissolved, the mass is removed from the fire, cooled, and filtered through a clean cloth to separate the undissolved portions of the shellac.

This solution can be kept for years in a tightly closed glass. To color it, a portion is to be cooked in a copper or iron ladle till it is thick as honey. Fine lampblack or vermilion is stirred in till the mass is thoroughly united. Then water is added, and the composition boiled again till it is a perfect solution. This black or red ink is first-class and can be kept well in tightly closed glass.

III

FLUID INK

Herr Andre, in Offenbach, uses an ink which has the useful property of remaining good for years in fluid form. I do not find it so good for the very finest work as those I have described, but for music and script it is excellent. It consists of:—

12 parts shellac
4 parts mastic
1 part pure ox-fat soap
1 part purified crystallized soda
1 part lampblack

This is mixed with water and boiled in a clean vessel, being constantly stirred till it is dissolved. Then the boiling is continued till the water has disappeared almost entirely. Fresh water is added and the boiling continued till everything has dissolved anew. Then the mixture is filtered through a cloth and kept in a vessel where it is secure against dust. If it is seen on cooling that it is too thick it can be thinned easily with water. Also, when it dries during use it can be liquefied by adding water, unless dust has entered it.

IV

TRANSFER INK

All the above-named inks are intended for use directly on stone. If it is desired to write on paper and transfer this writing to the stone, those inks mostly prove too hard, unless one would use warmed stones, as described later. This, however, makes added work: therefore, I give here the recipe for an ink excellent for cold transfers.

Shellac	3 parts
Wax	1 part
Tallow	6 parts
Mastic	5 parts
Soap	4 parts
Lampblack	1 part

The mode of preparation is exactly like that of the rest. The mass can be kept only in dried form, not mixed with water. The evidence that this ink is good for transfer work is that, after it has stood for some days, it still manifests stickiness when touched with the finger. If the ink does not transfer well to the stone under moderate pressure, it is too hard, and can be improved by mixing in a little butter or vegetable oil, but it is necessary to dissolve the whole mass again over the fire. If the design squashes under pressure, the ink is too soft. It is necessary to consider the temperature of the place where it is kept, and even the time of year, in order to produce the proper consistency of ink for the best transfer work.

V

HARD ETCHING GROUND

Certain methods of stone-printing demand, besides the ink, a fatty, acid-resisting mass to coat the plates. It is either the same as the material used by copper-plate etchers, or, at least, is very similar to it.

Etching Ground for stone is as follows: —

Wax	12 parts
Mastic	6 parts
Asphalt	4 parts
Resin	2 parts
Tallow	1 part

This is melted in an iron pan over a fire hot enough to melt the asphalt perfectly. Combustion is allowed to ensue till a third of the mixture has been consumed. When thoroughly cooled, it may be shaped in any desired form and saved for use.

A good surface is made also by common wax, boiled and burned till almost five parts of it have been consumed.

VI

SOFT ETCHING GROUND

For some processes there is needed an etching ground which has the property of not coating the entire surface, permitting the etching fluid to

penetrate at many spots uniformly, or, if it resists the etching fluid, still so easily affected by manipulation that it will admit the acid according to such manipulation. There are two ways to make it.

(1)	Thick linseed oil varnish	1 part
	Tallow	2 parts
(2)	Wax	1 part
	Tallow	5 parts
	Linseed oil varnish	3 parts

The application will be described in the instructions about aquatints, etc.

VII

ACID PROOF INK

So I name a color which has the property of resisting acid when the stone is inked with it. It is useful in many cases, and even necessary. It is well, therefore, to make a supply of it.

2 parts thick linseed oil varnish
4 parts tallow
1 part Venetian turpentine
1 part wax

All must be well melted, mixed with four parts lampblack, well rubbed down and kept in a closed tin vessel.

VIII

CRAYON

Chemical or fatty crayon is a composition intended to be used on the stone plate in dry form like Spanish or Parisian chalk. The inks described previously have the property of soaking into the stone and making it greasy where applied. The same happens if they are applied dry, the degree of their penetration and adherence merely being less.

The mixtures that may be used to make crayons are countless. Wax and soaps, however, are better than resinous materials. Therefore it is likely that the compositions here named will be pretty nearly the best.

(1) Wax 4 parts
Soap 6 parts
Lampblack 2 parts, roasted, or better still, made as explained before.

The wax and soap are melted together. The lampblack is added then. All is rubbed down fine on a hot plate, and then placed on the fire again till it is fluid once more. Then it is poured on a stone plate coated with a little oil, so that it forms a cake of about one eighth inch thickness. When this has cooled a little, it is cut into thin pieces and put away till needed.

(2) Wax 8 parts
Soap 4 parts
Lampblack 2 parts

Burn the wax till one half is consumed, then melt the soap with it, and treat the mixture as before.

(3) Wax 4 parts
Spermaceti 4 parts
Soap 4 parts
Lampblack 2 parts

The first three materials are melted together, the lampblack is added, and then the whole is treated as before.

(4) Wax 8 parts
Spermaceti 4 parts
Soap 4 parts
Lampblack 2 parts

The wax is to be half burned away, then the spermaceti and soap are to be melted into it, and the whole treated as the other formulas.

(5) Shellac 4 parts
Wax 8 parts
Soap 5 parts
Lampblack 3 parts

The shellac is to be completely dissolved with the wax by means of combustion after which the rest of the treatment is the same as before.

(6)	Shellac	4 parts
	Wax	8 parts
	Tallow	2 parts
	Soap	5 parts
	Lampblack	3 parts

The same treatment, except that the tallow is to be mixed in after the shellac has dissolved. This crayon is a little softer than the others. The same is true of the following two.

(7)	Wax	8 parts
	Tallow	4 parts
	Soap	6 parts
	Lampblack	3 parts

Wax, tallow, and soap are melted together and burned till one third of the mass has been consumed. Then the lampblack is added and the rest of the process is as before.

(8)	Wax	2 parts
	Tallow	6 parts
	Mennig	2 parts
	Lampblack	2 parts

Wax, mennig, and lampblack are heated and constantly stirred till the mennig dissolves in froth and changes from red to brown. Then the lampblack is rubbed in thoroughly, the whole warmed again properly and shaped into sticks.

These are the best compositions, thoroughly tested by me, and it is very good to make a stock of all or most of them. In the case of the recipes for chemical ink, the differences are not great, and it is largely a matter of taste as to which kind one may use. But in the case of the crayons, each of them produces a different grain which creates a particular effect; so that by using various kinds of crayon one will gain greater perfection of work, or, at least, find execution easier than with only one crayon. Also, they are in proportion to the greater or lesser roughness of the stones; and the darker shadings are easier to produce with soft crayons than with hard ones, while the hard ones are best for fine shading and outlines.

The lampblack used for crayons must be burned out first, else it will develop blisters, which is the case also if the composition is poured on the plates too hot.

Crayon that contains much shellac is likely to soften in damp air; therefore it should be kept in tightly closed vessels.

IX

CONCERNING COLOR FOR PRINTING

The manufacture of printing-ink or color is very difficult and dangerous on a large scale. I counsel all to take lessons from a book printer when he makes it.

The varnish must be prepared in the open, far from buildings, because of its combustibility. The best utensils and skilled workmen are required, because otherwise terrible accidents may occur, and even life be lost through explosion of the copper receptacle. Whoever does not require as much as one or more hundredweight of varnish in a year, would better buy it from printers or make only a small quantity, one or two pounds, and in an open vessel. For this purpose I will describe the process.

One, or at most two pounds of good old but not rancid linseed oil are poured into a clean iron pan which has a long, strong handle and is so large that the oil takes up only one half or, better, one third of the space. This is heated over a good fire till it burns, which is facilitated by applying flame to it. Oil that is too new has much water and other impurities that make it froth and run over. In that case the oil must be poured into the pan only in small quantities, when one must take great care to avoid spattering. As soon as the oil burns, the pan is removed from the fire and placed in a safe spot. If it is hot enough, it will continue to burn. It must now be stirred from time to time with an iron rod. Usually the flame increases under this stirring, but sinks again immediately at its cessation. So long as it does this, there is no danger that the flame cannot be easily extinguished if need be. But when it begins to continue burning with a great flame after the stirring stops, and at the same time to bubble and

froth, it is high time to cover the pan with a close lid and leave it covered till the oil no longer takes fire when exposed again to the air. Then a dry knife is introduced and as much oil removed as will adhere to its point. If it does not permit itself to be pulled into long threads when cool, but is too thin, it must be heated again until it gets the required consistency.

A good varnish dries very readily of itself, and it is not only unnecessary but inadvisable to mix a drier with it, as varnish so treated is too likely to off-set on the stone.

Several strengths of printing-varnish are needed for the various methods of lithography. Therefore a stock of thin, medium, and thick varnish is needed.

In making the thin, the oil has been reduced to about two thirds through combustion. It is somewhat like fluid honey and does not pull into threads.

Only a little more than half the oil is left in the case of medium varnish. It is thick as old honey and can be pulled into threads a foot long.

In the thick varnish the mass is not much less, but it can be pulled into threads of a yard in length; and further boiling makes it thick and tough like gum elastic. In the latter case it can be used with advantage when rubbed down with oil and properly thinned. But as soon as it has obtained the last-mentioned degree of thickness and toughness, it must be cooled quickly, for then it is not far from hardening completely and becoming worthless. In the beginning it requires a long while for the oil to reach the first degree of thickness, an hour or more for a pound. But after that period the thickening progresses rapidly, so that a quarter of the time will bring it to the point of total toughness.

To make printing color of the varnish, the proper amount of lampblack must be mixed in. The roasted or burned-out is best in this also, because the ordinary lampblack delays the drying and turns yellow with time.

The more lampblack is mixed in, and the more thoroughly they are combined by rubbing down, the better will be the color. But lampblack must not be added in such quantities that the color becomes dough-like.

In describing the various styles of printing I will describe the best

printing-inks also. I will merely make the general note here that designs on stone take the ink best when it is thin and fluid, but that there is less danger of off-set on the parts of the stone that are to remain white, if the ink is tougher or contains more lampblack.

Too much lampblack and too tough a varnish endanger the finer strokes and dots, however, so that they will not take ink, being, as lithographers say, rubbed out. The rubbing or grinding effect of too tough an ink is like that of pumice or other grinding material. With tougher varnish, clearer imprints can be made and they do not become yellow easily. But the inking is more difficult and demands greater skill, as well as heavier pressure in the press.

The varnish can be mixed not only with lampblack but with many other colors, which will be described when I reach color printing in this essay. Sometimes black lacquer is used with advantage instead of lampblack; and Frankfurter black is successful in the intaglio and aquatint methods.

X

RUBBING-UP INK

It happens often that weak parts of a design cannot withstand the etching fluid and are cut away; also, that fine lines are rubbed away through unskilled treatment during printing. Then frequently a very simple remedy is to ink the plate with the so-called rubbing-up ink.

This color consists of a thin varnish in which a portion of litharge of silver or mennig or white lead has been dissolved thoroughly over the fire, and a proper amount of lampblack added. Often it is good to add some finely powdered sand or powdered pumice stone.

To prepare this, a portion of the thinnest varnish is heated in a pan till it burns. Then about an ounce of finely powdered mennig (or another lead oxide) is stirred in to each sixteen ounces of varnish till all is thoroughly mixed.

A rubbing-up ink can be made also by mixing common printer's ink with vegetable oil, tallow, and a very little soap.

Each of these colors adheres to all those places that have a trace of fat and thus gradually makes faint places in a design receptive again.

Later I will describe how to use care in applying this color, so that the entire stone shall not be smutted and spoiled.

CHAPTER III

CONCERNING ACIDS AND OTHER MATERIALS

I

GENERAL PROPERTIES OF ACIDS

Probably most lithographers still believe, as I did once, that the etching with acids prepares the stone, and that the succeeding application of gum merely increases this preparation. Countless experiments have taught me that the exact reverse is true. Gum arabic and a few other similar bodies are the true factors in preparation, and the acids simply make the stone more receptive for them. Only sulphuric acid, which changes the surface of the stone into gypsum, prepares it without gum; but this is available only for a few intaglio methods.

The stone used for lithography consists mostly of limestone sated with carbonic acid. Most acids, and even the salts, possess more affinity for limestone than the carbonic acid, which latter is freed and escapes in gaseous form as soon as another acid touches the stone. If aquafortis, muriatic acid, vinegar, etc., is poured on the stone, there rise a number of air blisters, which are nothing except the escaping carbonic acid, and the applied fluid seems to boil, in degree according to its strength. The boiling and bubbling last till the fluid has sated itself with lime, after which it becomes still, and is impotent for further etching.

The direct effect is the solution and destruction of parts of the surface of the stone. If it has been coated in parts with a fatty substance that resists the etching fluid, the places so coated are left untouched, so that, when the stone is cleaned, all the fat-coated lines and dots are in relief.

If the stone is coated with fatty matter, but not so thickly that the acid is entirely resisted, it will pierce the covering and eat away more or less of the stone. If the etching is continued or if the acid is strong, the fatty coat will be destroyed entirely, the surface of the stone will be clean, and ready for the ensuing preparation. The preparation of the stone for pen drawings with oil or soap-water and several aquatint methods, is based on this principle, that a very thin coating of grease can be etched away partly or wholly, at will.

After eating away the surface of the stone the acids have the property of giving it a fine polish.

Therefore if the stone has been covered with a design, and then etched with an acid, it could be inked and printed many times, as long as it is kept properly dampened and not too much pressure is used in applying the ink. However, this could be done also with a thoroughly clean stone, using only water, though the polish obtained from etching makes it much easier. But this apparent preparation is not by any means sufficient to print with certainty; and it becomes perfect only if the stone is coated with a solution of gum arabic in water after being etched. If a plate that has been merely etched and not treated with gum becomes dry during printing, or even if too much pressure be used in applying ink or in cleaning with the more or less smutty cleaning rags, it generally takes color and smut which are extremely hard to remove.

We may assume, therefore, that the acids have the following effects on the stone: —

(1) They will not attack the parts coated with grease.

(2) They will penetrate more or less if the fatty coating is only thin.

(3) Where they touch the stone they dissolve it and eat it away.

(4) They give it a polish that facilitates printing. This polish disappears after a time on account of the cleaning with sponge or rag, but is replaced by a new polish produced by this very means.

(5) They do not prevent the adherence of fatty material later, as soon as the stone is dry, for which reason the parts prepared in the beginning

with acid and gum arabic must be prepared again by renewed etching, to take the ink.

(6) Finally the acids have the property of giving to prepared stones that have been used for impressions, a rough surface instead of a polish when they are applied again, because they attack some parts more than others, producing little pores with sharp edges which catch the ink. This fact, as I will show more clearly later, makes necessary extraordinary care if one wishes to clean prepared plates or correct defects with new etching, because unskilled handling will often make them worse.

II

THE ACIDS SPECIFICALLY

Nitric acid or aquafortis, muriatic acid, vinegar, tartaric acid, and acid of wood sorrel, all have nearly similar effects, but aquafortis and muriatic acid are used because of their greater cheapness.

Oil of vitriol or sulphuric acid, very much diluted with water, is available for light but not for extensive etching, because it transforms the surface of the stone into gypsum and deposits it again, so that after that the acid cannot penetrate at all, or only partially. If a part of vitriol, say diluted with twelve parts of water, is poured on a cleanly ground stone, there ensues a violent action which, however, is only brief. It might be supposed that the acid is sated with lime when it ceases to act, but if it is moved to another part of the stone it etches anew.

If the acid is washed from the stone and a woolen rag be used to rub it after it is dry, it takes on a mirror-like polish. In this dry condition it can be cleansed of color as easily as a copper plate, and if a stone thus polished is engraved with a steel tool, it is possible to make several impressions from it just as from copper. The polish is not lasting, however, because the skin of gypsum is very thin. But it is a useful method if it is desired to engrave the stone and ink it frequently to see the effect.

All the acids named have the property, previously mentioned, of etching the stone rough if it has been prepared before or used for impressions.

It seems that the gum unites more strongly with some parts of the stone than with others, admitting the acid in these latter places. Possibly, also, the bubbles caused by etching may help to produce this roughness by hindering the uniform action of the acid. This seems to be confirmed by the fact that an etched stone, prepared with gum, does not get nearly so rough when etched again with very weak acid as it does when stronger fluid is used.

In still greater degree does this appear when using citric acid or a solution of alum in water. Take a finely ground stone, pour diluted aquafortis over it, prepare it with the gum solution, and then dry it thoroughly with a clean rag. Now pour a little citric acid or alum solution on parts of it and let it dry. Then paint the parts so treated with a fat or printing-ink. If the color is rubbed off with a wet rag, it will be seen that the stone has become white again in all places except those where the citric acid or alum are. Those parts will have taken the color exactly as if they had been painted with chemical ink. The same occurs when applying other acids, but in a lesser degree. This effect will be mentioned in future for many methods. Here I will remark only: —

It happens often that the stone takes color on places where it should remain clean. This is caused by clumsy handling, unclean rags, etc., and occurs particularly at the ends, because they dry first and are more exposed to careless manipulation. These smutted places usually can be cleansed with a clean woolen rag and gum solution or even with a wetted clean finger. But sometimes the defect will not yield so easily, especially if the printing-color is soft. Then the only remedy is to prepare the stone over again, and that is the time when one must have regard to the roughening that ensues, if the stone is not to be rendered worse instead of better.

Therefore it is best in such cases to polish the ends of the stone with pumice stone till all dirt is gone, and then to etch with diluted acid and prepare anew with gum arabic.

To be sure, it is possible to dip a clean woolen rag in strong, even pure acid, and thus etch dirt away from the ends; but great care is necessary

that no drop may touch the design, as the ink that adheres to the latter is not strong enough to resist the acid. In thus cleansing the plate, the roughening is etched away by the violent action, and a new polish is obtained.

Still, in either method of cleaning dirty places, great care must be taken not to touch roughly, press, or rub with dirty fatty rags or with dirty, fatty fingers before the gum arabic is on it. The acid eats away all the previous material used in preparation, and leaves the plate practically in its clean, natural state. Consequently it will take on grease readily, and the application of gum is essential.

It is feasible to mix the gum directly with the acid solution, but this mixture must be made fresh again each day, as otherwise it loses much of its value.

The following points are important: —

First: If the grease remain long on a stone that, though prepared, has lost its coating of gum, it will penetrate the surface, and according to its amount and fluidity, will sink more or less into the stone, which will retain its polish on the surface but become more inclined to take dirt. It is better, therefore, to leave a small amount of gum coating on the stone in such cases.

Second: As only the extreme outer surface of the stone is prepared by the gum, and this is rubbed away gradually by wiping during the printing, so in the same proportion of wear and tear the original preparation would become lost, if it were not renewed from time to time, that is, if the stone were not again coated with gum. Twice a day, however, is enough.

Third: Because of this susceptibility of the surface to injury, a prepared stone must not be rubbed strongly with fatty material, because this damages the surface and the stone would readily soak up the fat.

Fourth: If a prepared plate is totally denuded of gum, and has been dry for a time, especially if it has already lost a part of the preparation through printing, it will incline very much to take color and smut. Therefore, when it is necessary to stop printing, it is well to coat the plate at once with gum, but only with a very thin coat. If this has not

been done, and it is desired to use the plate again, great care must be taken to wet it with the very purest water, or, better still, with diluted etching fluid, for instance one part aquafortis to five hundred parts of water; and then to coat it with gum. To neglect this precaution may cause the total ruin of the plate. For safe-keeping of the plates, if they are to be used again for printing, the coating with gum is, therefore, absolutely necessary.

Fifth: Gum can prepare only a thoroughly clean stone or one properly etched. Therefore, if the surface of the stone has even the least trace of grease, it will take color, no matter how thickly it may be coated with gum. On this fact is based the method of transferring copper-plate impressions and other printed subjects, as will be described later.

Sixth: If the stone has had fat on its surface, and this fat has been etched away again, the power of the gum asserts itself, and the stone will be thoroughly prepared even if the fat has soaked considerably into the body of the stone.

Seventh: Mere grinding of the stone is not sufficient to attain a complete preparation through gum alone. Therefore, if an otherwise clean stone has some places after grinding where the fat has soaked in deeply, and one coats it with gum, the stone will take color after a time on these fatty places, as soon as the inked rag has been rubbed over the stone many times. However, this taking-on of color is only slight if the gum solution is thick, and long-continued cleaning will transform it into complete preparation.

Eighth: From both preceding observations we learn: —

Printing forces the color to sink considerably into the stone. If such a stone is required for new designs, it is not practicable to grind it so much that all the fatty places can be ground away. Therefore it is ground only till it is thoroughly even again. Then it must be well etched; otherwise it may happen that in printing the surface will rub away and the entire previous writing or design will appear again, a trouble hardly to be remedied.

If the stone is dirty in the middle, it can be cleaned in many cases by

pouring on a few drops of oil of turpentine and the same quantity of gum solution, and rubbing it clean with a woolen rag. Then it must be washed with a wet sponge, after which it is inked. If it has not lost the smut, the only remedy is new preparation. As this must be done differently for each different lithographic style, it will be described in its place.

If fat has soaked well into the stone in places where it is not desired, it is always very difficult to remove it without injuring adjoining parts. Correction of crayon work, if it has been etched and used for printing, is especially difficult. It is true that the defective parts can be cut out easily with a sharp instrument, but then these places must be prepared again. If weak etching fluid is used, it will not suffice. If strong fluid is used, the fine parts are easily attacked, and at the same time the surface will become roughened so that the stone often blackens entirely in the corrected parts. To avoid this trouble, and to facilitate corrections, I made many experiments to discover an acid composition that should prepare a stone anew and perfectly and yet not roughen the surface. I found the best material in phosphoric acid, especially when mixed with finely crushed nutgall.

Water in which phosphorus has been kept a long time becomes acid and etches the stone. The acid can be obtained more quickly by burning the phosphorus and catching the smoke. This method is somewhat expensive, but one does not need much, as it is used only for correcting defects.

If a few drops of aquafortis or other acid are poured on a clean ground stone, it will be etched. Now wipe the etching fluid off clean and coat the plate with soap-water or chemical ink. As soon as it is dry, clean it of the fatty coating with a few drops of oil of turpentine. If it is dampened then with water and inked, it will take color everywhere, even at the etched places. If gum is mixed with the acid, the same result occurs, though the stone has been thoroughly prepared where this mixture touched it. From this it appears that soap-water (and the alkalis in general) can destroy the preparation given to the stone and make it receptive again to fats.

It is different if phosphoric acid is used. This makes a preparation that can be destroyed only by very frequent coating of soapy water.

Still more durable and resistant to soap is the preparation if fine nut-gall is mixed with the phosphoric acid and water solution. Nutgall gives even the other acids the property of resisting soap more than ordinarily. The study of this effect led me to invent the method of transforming a relief design into intaglio. Also, it is only by the use of phosphoric acid that one can do thoroughly that style of lithographic work which resembles the scraped style in copper, or the so-called black art.

III

GUM AS THE REAL PREPARATION

If a cleanly polished plate is sprinkled with a few drops of gum arabic dissolved in water, the sprinkled places will take no color so long as they are wet. When they dry, color will adhere, but can be washed away easily with a wet sponge. This shows that the gum alone will prepare the stone. The preparation will become more durable, however, if the stone is etched first.

In both cases, however, the preparation extends only over the outermost surface of the stone, penetrating only slightly, so that the least injury will make it take color as soon as it is dry. On this fact is founded the intaglio style of lithography. Therefore, if a clean ground stone is etched, then prepared with gum and dried clean, it can be coated with printing-ink or other fat substance (excepting soap and all alkaline compositions), and there will be no danger that it will lose its preparation. The thicker the gum coating, the less can the fat penetrate.

In printing, during which the stone must be kept wet, only the original coating of gum is necessary; but as the surface thus prepared soon diminishes under the frequent wiping, it is necessary in some forms of work to mix gum with the printing-color or with the water used to dampen the stone. More of this will be explained in the proper place.

Here I will add only that the domestic gum of cherry and plum trees

is good for preparing stones some years and worthless in others, when it cannot be dissolved in water. In possessing the properties for preparing stone, the juice of many plants and fruits, sugar, and most mucous materials of the vegetable and animal kingdom, such as white of egg, approach gum arabic more or less. The latter, however, is to be preferred because of its reliability.

IV

CONCERNING PARTIAL PREPARATION

Here I impart my experiences in regard to an astonishing phenomenon that occurs often in lithography and gives much trouble, especially to beginners. It is the so-called imperfect or semi-preparation, wherein the stone betrays a strong inclination to take color, and still will not do it or will do it only partially.

(*a*) If a cleanly ground stone is marked with chemical ink, etched, and prepared, the marked places will take the printing-color and produce impressions. If, after the stone is inked, one rubs strongly with the wetted finger, the color can be wiped from the design, especially if it has not been on the stone long and has been standing in a damp place. A place whence the color thus has been removed does not take it readily when the inking-roller is applied again; and the reluctance is the greater in proportion to the length and violence of the rubbing and the toughness of the printing-color. The stone shows clearly the traces of the penetrating fat; indeed, if the stone is rubbed with a wet linen rag that is inky from previous use, the design will reappear in black. But as soon as the roller is used, instead of inking these places, it takes the color off; and whatever means may be tried to make the defective places receptive again to color, it remains difficult, often impossible.

What has happened is that the wet rubbing has cleansed the surface of the stone of all its fat and at the same time has polished it and made it slippery. It is a sort of preparation; and though the fat of the ink has penetrated into the interior of the stone, the accidental preparation still

offers an obstacle which prevents the printing-ink from adhering to the fat in those places. As I will show, these places can be prepared again thoroughly.

(*b*) Another case is when the design is too weak, and has been attacked by the etching-fluid too powerfully, though without being destroyed. Here the printing-color usually is removed by the ink-roller, even though it adheres pretty well when being wiped.

(*c*) A third kind of imperfect preparation is when a stone inclines to take color or smut on prepared places. This happens sometimes in part, sometimes over the whole surface, which latter effect is described by saying that the stone has acquired a tone.

The cause of this phenomenon may be one of many. It is either due to the appearance of a fat that has been in the stone, or to the fact that unskilled manipulation has destroyed the preparation partially.

Thence follow several observations again: —

(1) Mere wiping with clean water will give the stone a sort of preparation if the material used for wiping is suitable. This preparation is incomplete, but can be transformed very easily into a complete one. This incomplete preparation is according to the strength with which the rubbing material affects the stone. Linen and cotton stuffs have the least effect. More potent are animal wools and hair, silk or wet leather. The printing-color itself has a preparing property if it is made of very tough varnish or contains much lampblack. This effect is increased if Frankfurter black or powdered charcoal is mixed with the color, and the stone is kept very wet.

(2) The partial preparation is produced more quickly and made more durable if the water contains gum or gummy stuffs.

(3) The operation is still quicker if a weak etching fluid is used. A stronger fluid would make the preparation a complete one, but would also injure the good spots. Then again one must remember that the second etching produces the roughness discussed already.

(4) Grinding with sand, pumice, and other grinding materials also produces partial preparation, which is transformed easily into complete

preparation by applying gum. Here, however, the circumstance is noteworthy that a plate that has been blemished by rubbing can be made to do the reverse, namely, to take color, by means of light grinding with water. Assume, for instance, that a plate designed and prepared in relief style has been spoiled by handling so that the design refuses to take color. It is necessary merely to rub it all over with water and fine sand or to clean it with oil of turpentine so that all printing-color is removed from the surface. Then place it in a receptacle containing a great deal of very clean water. If it is ground delicately then with a very clean pumice stone, without destroying the traces of the fatty material that has soaked in, it can be brought to take color again as well as ever. Take a little of the before-mentioned acid-proof ink, smear it on the color-stone, and apply a clean linen or cotton rag. Wipe the stone that is lying in the water very gently with this rag, and the color will fix itself bit by bit on all parts of the design, even if the entire relief produced by the etching should have been ground away. It is necessary only that the fat shall have soaked in sufficiently; and this usually is produced soon enough by the printing. After the plate has accepted color completely, it is to be completely prepared by light etching and with gum, and then it will take the color properly from the ink-roller.

If this experiment is to succeed, it is to be noted that in grinding there must be no trace of fat on the stone or the pumice, because the rubbing during grinding might transfer this greasiness to those parts of the stone that are to remain white. Care must be taken, also, not to press too hard in applying the etching color, because the places that have been cleansed of all gum by the water, and thus are inclined to accept color, will smut easily. Finally, the stone must not be permitted to dry before it is fully prepared again by etching and gum coating, for it might easily become entirely smutted and useless.

This experiment leads to the conclusion, which has been proved correct in many ways, that a soft rubbing in clean water with printing-color, especially if it contains tallow, is very well adapted for transforming the incomplete preparation into a condition of accepting fat perfectly, and of

giving injured places new potency. Also, that the contrary effect can be produced by violent rubbing, especially with wool, leather, or tough colors, because this prepares the wet stone and makes it useless for accepting fat. The first method may be used with advantage, therefore, for reëstablishing a vanished design. The second method is good for getting rid of smut. If the smut has occurred in previously clean and thoroughly prepared places, it can be destroyed entirely. But if it is only that the deeper fat has lost its superficial polish, and has appeared again, the stone will be only partially prepared by this last method and must be newly prepared on the desired places with weak etching-fluid and gum, for durability's sake. It is easy to see how important this circumstance is. With the one and the same process in various degrees of manipulation, opposite results can be produced; and I may declare that only he is to be termed a perfect lithographer who has exact knowledge of this especial matter.

(5) It has been mentioned already that every sort of preparation can be destroyed by a renewed etching, and particularly with alum and citric acid. The same is caused by soap and alkaline compositions; therefore also by chemical ink if it contains a sufficient amount of alkali.

(6) Simply letting the stone plate rest produces important, often contradictory, phenomena. If smeared parts refuse color, clean water poured over these places runs from them as quickly as it does from the fatty parts. This is the surest sign that they still have fat, though it is not sufficient to attract the color. If such a stone is permitted to lie idle a few days, even if coated with gum, it will often take the color thereafter. On the contrary, if a stone plate has taken on color at the well-prepared places (usually readily removable by wiping with oil of turpentine and gum solution, but generally reappearing), it need merely be inked after such cleansing, coated with gum and left idle, and in a few days it loses the readiness to take dirt.

The cause of both phenomena is that in the first case the fats that lie deep gradually work upward into the partly prepared surface and practically reëstablish their interrupted communication with the printing-

color. In the second case, the small quantity of fat that has adhered merely to the surface has penetrated into the stone, so that it loses its effectiveness. Added to this, in the latter case, is the fact that the linseed oil, and the varnish prepared from it, acquire the property of losing their fats when they are dried in the air, and thus will take color poorly or not at all. This observation led to the invention of an artificial stone or stone-paper.

(7) In contrast with preparation by wet wiping there is the wiping with dry and fatty bodies, which produces full acceptance of color on the partially prepared plate, while in the case of the fully prepared plate there occurs at least partial color acceptance or semi-preparation. As every property of the stone can be used for good impressions just as well as it serves in unskilled hands to ruin a design, so in this case; the lost parts can be restored through proper use of rubbing with a dry, fatty substance, and the clean, prepared portions of the plate can be smutted. There will be more about this.

V

SHORT REVIEW OF THE PRECEDING

As the entire art of stone-printing depends on proper preparation, it will not be out of place to express my views as to the nature of the process. This will serve also as recapitulation.

(1) Limestone has countless little pores. These can soak up fatty as well as watery substances.

(2) These can adhere easily to the limestone particles, but are easily separated again, as long as the nature of the stone is not altered. This alteration is produced most readily by sulphuric acid, tartaric acid and phosphoric acid.

(3) Water evaporates from the pores as the stone dries. Gum and other slimy substances do not.

(4) Fats soak into the stone more and more. There is no means of destroying them except to remove the limestone itself by grinding or etching.

(5) Printing-color cannot adhere to the stone so long as a proper amount of moisture forms a wall between it and the stone. Under any circumstances it adheres only poorly to the lime particles, and assumes great power of adherence only when the pores of the stone are filled with fat, which are pinched in them, so to speak, and with which the printing-color strives to unite because of mutual affinity.

(6) This stronger adherence (or complete color reception) thus happens only when the outer color can reach and touch the inner fat. If the latter is deep in the stone, so that the communication is broken, it becomes difficult and the communication must be restored.

(7) This interruption occurs either if the color is rubbed away by force and with help of moisture, or if a substance that closes the pores unites with the stone.

(8) The rougher, sharper, and more angular the pores are, the more readily does the color find adhering points. It adheres at first to the surface by virtue of merely mechanical conditions. But when the moisture which hinders a complete union and greater penetration has dried, the color begins to penetrate deeper into the stone and to fill its pores. The most color will always adhere to rough spots. Therefore, it happens often, in some styles of work, that a stone too highly polished will seem perfectly black when inked, and still fail to yield a strong impression. For the same reason the impressions from soft stones usually are the stronger, especially if the mode of printing demands the use of thin printing-color.

(9) The effect of the etching fluid is in part a greater polishing of the surface, in part a filling of pores. Both make the stone reluctant to take color.

(10) If the stone has been prepared and polished already, it can be made rough again and receptive to color by being reëtched. At the same time the prepared surface can be destroyed by etching, and a communication established with the fat lying in the interior. The result is according to the manipulation.

So much in general. In describing the various styles I will make everything clearer.

CHAPTER IV

THE NECESSARY TOOLS AND APPLIANCES

In lithography there is use for many various tools and utensils. I will mention here merely those that are made primarily and exclusively for the art.

I

CONCERNING STEEL PENS

One of the most necessary tools of lithography is the steel pen for writing and drawing on the stone. Simple as its manufacture is in principle, it demands much care and skill. The beauty of the work depends largely on a good and well-cut pen. The best artist, using the best chemical ink on a perfectly prepared plate, cannot do good work unless the pen is good and cut to suit his hand. Therefore it is necessary to learn how to make these pens, because, apart from their costliness, it is difficult to get a suitable one from a worker in steel. The ordinary steel pens that can be bought ready-made from stationers are fairly available for coarser writing and drawing; but for better work one must have much finer pens.

Following is the way to make them: —

Take the spring of a pocket watch, not too small nor too broad; one and a half to two lines in breadth is best. Clean off all fat by polishing with sand or chalk. Lay it in a glass or porcelain vessel, and cover it with a solution of aquafortis and water in equal parts. Let the acid etch the steel till it has lost about three fourths of its thickness, and has become as pliable as a similar strip of letter-paper. From time to time the steel must be removed from the fluid and dried with tissue paper. This produces uniformity of etching. The steel rarely is quite uniform, and it has happened to me often that it is attacked unequally and that holes are eaten into it before it has been etched away sufficiently. That this, how-

ever, is due mainly to the quality of the acid, I learned because I found that the same steel would be attacked clean and uniformly as soon as I obtained aquafortis from some other source.

A pen is poorly etched if it has many elevated points or pits and holes. The former appears to result from insufficient cleansing, the latter is due to the quality of the acid.

Oil of vitriol diluted with water, or nitric acid can be used.

Those who have a very light touch may etch their pens to great thinness, and will be enabled to do very delicate work. For a heavy touch they must be firmer, otherwise fine strokes will look shaky.

When the steel is thin enough, it is removed and cleansed with fine sand that it may not become rusty in future. Then it is cut into pieces two inches long with good English shears. Now these must be shaped half-round. To do this, lay them on a flat stone and beat them lengthwise till they bend, using a small watchmaker's hammer, whose faces are pretty thin but well rounded. Two or three sheets of paper laid under the steel facilitate the work.

Another way to give it the half-round form is to file a groove into a stone, giving it the exact shape the pen is to have. Into this groove lay the piece of steel, put in a drop of vegetable oil, and polish with a steel instrument whose end resembles a broken but well-rounded nail. Use sufficient pressure, and the steel will gradually assume the desired shape.

Either of these methods may be used, according to preference. It is to be noted that the degree of roundness depends on the artist's need, one finding a well-rounded pen better, another preferring one not so well-rounded. The less the pen is rounded, the more it will resemble a brush when used, but the points will not spread so well without considerable pressure. The more they are hollowed, the stiffer are the pens and the more easily will the points spread when pressed.

After the pen is curved, it must be cut. With small, well-sharpened scissors cut a slit about one line in length into one end. Then cut away from the two sides as much as necessary till the point is sufficiently fine. Do not cut away too much at once, as the pen bends easily and then must

be straightened out again, which demands especial skill. It is well to do the cutting from the point toward the sides.

A good pen must have both points very uniform, so that they touch perfectly and lie on the stone evenly in the position given them by the hand when working. The cutting alone will do this, but a small, very fine whetstone may be used to aid.

A newly cut pen is somewhat rough at times and cuts into the stone, thus gathering powder that hinders the work. This defect generally cures itself after a few strokes on the stone. Beginners generally spoil their pens by bending them every few moments. Then they must be straightened out, which demands practice and judgment. It cannot be described, because the bending may assume a thousand shapes. It may be mentioned, however, that the points must always touch, but must under no circumstances interfere, one being forced behind the other. It is good, sometimes, if one can see through the slit when looking backward from the point. Some even cut a tiny bit out of the middle for this purpose, but that demands great skill and extremely good scissors, as otherwise the opening will be too large, which will spoil the pen entirely.

The ordinary drawing-pens, which can be loosened or tightened with screws, can be used very readily for drawing lines, if their points are made from very good steel that can be ground very fine and thin. However, for much line-work, for instance the background of a picture which consists of lines hatched crosswise, it is better to use the other pens. The ordinary drawing-pens are too likely to catch a little dust or dirt between their points, and then will spoil the lines.

Of all work of the pen style in lithography, the most difficult is to draw very fine and even lines with a ruler. I have succeeded best by using a pen previously so cut or ground that both points touched in the position in which I was accustomed to hold the pen when guiding it with the ruler. It is evident that the pen must be held to the ruler on its side, so that the groove that contains the ink does not point in the direction of the ruler, but away from it. It is well if there is a tiny space in the slit, as it helps the free supply of ink.

II

CONCERNING BRUSHES

Brushes are used for various purposes, as to prepare the plates, cleanse, etch, etc. Here, however, we speak chiefly of the small brushes required for writing and designing. For this are used the very smallest and best miniature brushes, and they must be especially treated.

If it is desired that the brush make thicker strokes under pressure, the ordinary condition of it, in which all the bristles come to a point, is quite sufficient. But it is very difficult to lay on strokes of uniform thickness with them. Press the brush on the table, spread the bristles fanwise with a knife and cut away from each side about a half-line deep. Turn the pencil to the other side, stroke it again to spread it, and cut the same amount as before from each side. Continue this till there remain only ten or twelve bristles of the original length in the brush. Then cut these even at the ends. These should not be altogether the middle ones if the pencil is to be first-class. Neither should they be too far apart. They should hang together well when the brush is dipped into the ink, but not so closely that they will not let the ink pass well. With a brush successfully trimmed thus, the handsomest drawings, resembling copper plate, can be done with ease.

For coarser strokes, coarser brushes are needed. More bristles are permitted to remain in them.

III

CONCERNING ENGRAVING NEEDLES

These serve for the intaglio process, to draw into the stone, and must be of the best and hardest steel. In Munich there are also used the little five-angled watchmakers' borers, which are glued between two pieces of wood planed round in form of a pencil and so cut at the end that only a bit of the tool is visible. In using very thin needles one has the advantage that they are ground and sharpened easily.

For coarser strokes, coarser needles are needed. For fine strokes,

especially if they are to go in all directions, the needles are best ground perfectly round.

IV

CONCERNING THE DRAWING-MACHINE

To transfer drawings very accurately and reversed on the stone, which is necessary especially in the case of charts and plans, a pantograph is used in Munich, which is so arranged that the stone is upside down and elevated. The inscribing-needle is just opposite the one that is managed by the hand, and when one follows the lines of the original exactly, there results a perfect but reversed copy on the stone. Such drawing-machines can be obtained from Herr Liebherr and Company in Munich. This skilled mechanician also makes a sort of pantograph of his own invention, with which drawings can be transferred to stone, reversed or otherwise, and in any desired proportion. Pictures of such machines may be obtained from him.

V

CONCERNING OTHER APPLIANCES

These are: a grinding-table, an etching-trough, some rulers, a writing-table, some music-writing pens and rastrums for those who wish to print music, small brush for spatter-work, a wiping-machine for the wiping method, several rollers and balls for inking, and some presses for wetting and pressing the paper.

Any firm table may be used for grinding, but it is better to have one made heavy enough to resist the strain of the powerful friction, and so made that the stones can be fastened on it readily. If this work is done in a room, it must have a depression in the middle and a hole, that the water may run off into a receptacle. Along the sides should be a low rim, that the sand and dust may not drip all over the floor.

The etching-trough is a square, well-pitched box whose bottom is depressed toward the middle, that the etching fluid may gather there and run through a hole into a receptacle, so that it can be poured over the

stone again. The trough must be large enough to accommodate the stones easily. These must not, however, touch the bottom, but must rest on little pieces of wood or cross-pieces.

Besides the ordinary rulers, a large, broad one is required, about three to four feet long, five inches wide, and so shaped that on one side it is one-half inch thick, on the other only two lines thick. On this latter side a strip of pear wood must be glued and very truly planed off. Thus it can be used for drawing lines, although the real purpose of this ruler is only for supporting the hands when working on stone, that they may not touch the prepared surface.

If the work-table is made with high pieces at the ends so that the ruler can rest on them without touching the stone, no ruler supports are required. Otherwise one must have these two pieces, a little higher than the stone, so that the ruler may rest on them.

A specially made work-table has another advantage. In the middle there can be a turntable on which the stone rests, so that it can be moved easily into any position, something that is very difficult with large stones without this arrangement.

Music-writing pens are brass or silver tubes which have the shape of musical notes underneath, and which take up such a quantity of chemical ink that one can make about twenty notes without re-dipping. That they shall not take up too much ink, a fine wire is fastened in the centre. These instruments must be very exactly ground and their use demands some skill if the notes are to be uniform.

Instead of this instrument a piece of wood may be used, but this must be inked anew for each note. To avoid dipping too deep, it is best to spread some ink on a little stone and ink the instrument from this. It must be wetted in the beginning, that the ink may be sucked up about three lines high. After that the ink on the stone need merely be touched with it, and this makes the work very uniform. Beginners find this easy to use. But one works more swiftly with the other.

Of the rastrums, there is nothing to say except that they are of steel and very even at the ends so that they touch the stone in all places. They

serve to draw the five lines for music. For making the broad strokes for notes, one can use coarse drawing-pens, or coarsely cut steel pens; but the best are those adjustable drawing-pens that are made from three blades.

The brush for spatter-work, the wiping-machine, and the dauber will be described in the description of the styles of work for which they are used.

Ink-rollers and balls are for laying on the printing-color. The latter are made from soft leather, stuffed with horsehair, like the ordinary book-printer's balls. The former are wooden cylinders with thin handles, of any requisite length and about four to five inches thick. They are wound with two or three thicknesses of woolen cloth and then covered very firmly and evenly with leather. Usually there is used sheep's leather from which the grease has not been entirely removed. Calfskin, worked white, is good and more durable. Dogskin is considered best. Some printers use soft red calfskin, turning the inner side out. The leather must not be stitched with linen but with silk thread, because linen does not take the ink as well as leather and silk do. The leather must be dampened when being drawn over the cylinder.

A fair stock of these rollers is required, because they are liable to become water-soaked during use, when they lose much elasticity and fail to give good service, so that dry ones must be on hand.

It is not well to have movable handles on the rollers, because then they are likely to roll over the stone too lightly and it is not within one's power to lay on the ink thoroughly. To prevent blistering the hands, thick leather covers may be used. Then it is possible to use any desired pressure.

Paper presses are needed both to obtain a uniform dampening of the paper as also to restore the proper flatness to the printed paper. Models are to be seen at the shops of all book-printers and binders.

CHAPTER V

CONCERNING PAPER

THREE kinds of paper are used mainly in lithography. They are:—

(*a*) the transparent, oiled or varnished paper;

(*b*) underlay or waste paper; and

(*c*) the printing-paper.

I

TRANSPARENT PAPER, AND THE TRANSFER OF OUTLINES TO THE STONE

Oiled paper is used for tracing a drawing accurately and then transferring it to the stone either by transferring or by re-tracing it on the stone. It must have the following properties:—

(1) It must not smut the original drawing on which it is laid. Consequently it must be absolutely dry.

(2) It must be very transparent, like glass, so that the underlying drawing or painting can be seen perfectly.

(3) The ink or lead crayon used for copying must lie on it easily and plainly.

It is at its best if it is easy to work on it with a fine brush, using Chinese ink, or, (if the drawing is to be transferred directly to the stone), with the soft chemical ink described under the caption "Transfer Ink." Generally this can be done without further preparation in the case of most papers made transparent by oiling. Varnished paper, however, which is far more transparent, generally must be well washed with milk and dried again beforehand, that it may take the ink well and permit work with the finest strokes.

(4) Finally, a good tracing-paper must be very fine, pliable, tender and yet not in the least brittle. There is some very transparent varnished paper, but it breaks at the first attempt to bend it, so that it is hard to trace the drawing afterward on stone with the tracing-needle, because

nearly every stroke tears the paper and the lines and outlines become coarse.

Very good transparent paper may be made as follows: —

Take the finest writing or vellum paper and soak it with nut or poppy oil, mixed with a little sugar of lead to make it dry more readily. When well soaked with oil, dry it a bit between waste paper and hang it up. Usually it is available in a few days. This paper is cheaper than the paper sold by stationers under the names of straw paper, etc., and about equally transparent. Still more transparent will it be if instead of the oil a varnish cooked from the oils is used. In this also the sugar of lead is an excellent drier. To make the varnish easier to manipulate and more readily penetrative for the paper, it may be thinned down with oil of turpentine. If it is desired to manufacture a greater quantity of this paper, one sheet is laid on another and painted with varnish. Then the whole mass is left for some time covered with a stone plate or a board, that the varnish may soak properly and evenly into all the sheets. Afterward the sheets are hung up singly to dry. The more varnish they have, the more transparent will they be; but too much is not good. Care must be taken that no drops of varnish adhere. It is best to brush the varnish evenly over each sheet before hanging it up.

Silk paper, such as is used in copper-printing to lay between impressions to prevent off-set, is still better for varnishing because it is finer. Only it must be very even and have no holes. The very greatest fineness of paper is desirable, for the reason that then the strokes made by the needle on the stone are fine and not coarse.

Instead of varnish made by boiling down nut or poppy oil, one can use Venetian turpentine, which merely has been thinned down with one half as much oil of turpentine. Such paper generally is dry enough after twenty-four hours. Too large a quantity must not be made at one time, because it becomes tough and brittle after a while.

Even with the most transparent paper it occurs that certain delicate drawings, and especially color pictures, will not show through sufficiently. Then the drawing must be fastened to a window pane to obtain added

illumination. This manner of work is very uncomfortable, however, and the arms hurt one soon, so that it is necessary to stop. It is better to have a tracing-board made with a strong, clear pane of glass in the centre. Under it is a mirror so adjusted that it reflects light upward through the drawing.

It is understood, of course, that in tracing only the outlines are copied and not every stroke of shading, etc. Although the final work is greatly facilitated by the observation of the utmost care in tracing, the tracing of every little detail will merely make the work involved and perplexing. Practice must show the proper degree of exactness. A very good and skillful artist often needs only a few main outlines, to reproduce the original picture with the greatest accuracy.

Once the drawing has been traced sufficiently, the transfer paper must be coated very lightly and evenly with red chalk. Then it is fastened to the stone with wax and all the lines are traced under moderate pressure with a well-polished needle whose point is not sharp but rounded. Where the needle presses the tracing-paper, the color that is on the other side will take hold of the stone and thus transfer the drawing to it. If the needle is too sharp, it will injure the paper, and often the stone and the etching surface. The color on the paper must be rubbed off very carefully with a soft rag. If it is too thick, it will transfer itself coarsely to the stone. The red chalk may be put on the side of the paper that has the drawing on it, or on the reverse. This is decided according as the picture is to be on the stone in the same position as the original or reversed. If the impression is to be like the original, the drawing on the stone must be reversed; therefore in that case the tracing-paper is coated on the same side as the drawing. This side is laid on the stone, and the picture, which shows through, is traced.

In some cases it is good to transfer the drawing from the tracing immediately to the stone without tracing it with the needle. In this case, the paper is not coated with red chalk. The paper is merely laid on the prepared stone, drawing face down, and put through the press. If the drawing has been made with the chemical transfer ink, blackened with lamp-

black or colored with vermilion according to need, it will transfer itself to the stone. This will occur also in the case of a clean stone prepared for pen drawing if the drawing is made with lead pencil or with red chalk, wet or dry. Even the ordinary ink made from nutgall and vitriol of iron will transfer if it contains a little sugar or gum, but the paper must be well dampened and good pressure must be applied to the press.

In the pen-drawing process, the stone must be cleansed of possible surplus of color after the transfer. This is done by light rubbing with sand. It is not necessary in other processes. Any surplus of color that may have fixed itself to the stone is removed by gentle dusting with a soft brush.

II

WASTE PAPER

This is used partly for cleansing plates, partly and chiefly as underlay in printing.

If sheets are to be printed on both sides, usually a little of the first impression off-sets on the underlay paper, and if it were used again at once, it would off-set on the next impression. Therefore a fresh underlay paper must be used for each impression of the second side.

This must not be coarse, for fear of causing unevenness or holes in the leather in the printing-frame or in the so-called scraper-wood that makes the impression. A good quantity of this must be on hand, that fresh paper may always be available while the used paper is drying again. Each sheet that has been used should be hung up at once, and not more than three or four sheets should be hung over each other, to facilitate the drying. A special appliance is needed for this as well as for drying the impressions. A number of slats are fastened to the ceiling, leaving a space under it of about two feet, and about one foot distant from each other; and the sheets are hung on these with a pole made for the purpose, such as may be seen in any printery.

III

PRINTING-PAPER

Not all kinds of paper are equally good for lithography. On the whole, however, it may be assumed that this form of printing is very similar to copper-printing and book-printing, and that the paper that is good for these branches is suitable also for the stone, if only it does not contain too many impurities, grains of sand and other substances that make any considerable roughnesses. Such roughnesses, if considerable, have an ill effect not only on the impression, but chiefly on the leather in the printing frame. If the scraper is of wood, the leather will suffer less, but there will be caused grooves in the scraper that must be planed out again, because otherwise each following impression will show a more or less plain streak. If the scraper is of metal, the leather may tear or the stone itself may be injured if the foreign substance in the paper is very hard. Therefore it is well to hold the paper to the light before dampening or printing and to remove any apparent defect of magnitude with a little knife.

Usually the paper considered most excellent for copper-plate work is thick, tender, uniform paper, half-sized or not sized at all. It may be the same for lithography. However, it must not be supposed that good impressions cannot be obtained with sized paper. I have seen some that were as good as, and even better than, impressions made at the same time on unsized paper. Much depends on the dampening of the paper, on its make, and chiefly on the manner of sizing it. On the best sized English vellum paper, I have made blacker impressions than I could make on the best Swiss copper-plate printing-paper, so that I had to use fifty per cent less printing-color. On the contrary, in using an indubitably genuine English vellum paper with a bluish tinge, which had been sized only too well, I could not get good impressions despite all efforts. It was very hard to dampen also. Every sheet must be dampened singly, turned frequently and manipulated to smooth out the thousand irregularities that are caused by the moisture. Equally difficult to use were some sorts of genuine Holland paper, because they took color reluctantly. If, however,

the correct degree of moisture is attained, if the paper takes it well, and, finally, if the color is right for it, it can be used with thorough success.

I must mention a circumstance that may defeat all efforts of a beginner should he try to use a certain kind of paper which is very handsome, durable, very white, well sized, but a little rough and possessing an odor somewhat resembling honey as well as urine. Sometimes it is called *Kühnel*, and comes from a French factory. This paper has the property of depriving the stone of its preparation, and consequently to smut it. This paper can be used only for dry printing, where it does not require any dampening at all.

It is said that this property of smutting the stone is due to the chemical bleaching. Others ascribe it to a peculiar kind of size. Perhaps it is both. The same defect is found in many sorts of colored papers if there is much alum in the coloring-matter, or if the tints are made from alkaline colors or those that contain soapy matter, or if it has been smoothed with soap. This, however, is readily understood after my explanation of the chemistry of the stone.

IV

DAMPENING THE PAPER

Dry paper may be used for printing. In certain work it is necessary, in order not to spoil the paper. As a rule, however, paper is moistened in lithography as well as in other forms of printing, to make it softer and more receptive to the printing-color.

After what I have said of chemical printing, it would seem that, as dampness is antagonistic to the reception of color, the moisture of the paper would hinder, rather than aid, printing. But experience proves the opposite. A damp paper takes color better than a dry one.

But this is not because damp paper is an exception to the rule. On close study, we see that here, too, it only proves all that I said about the stone.

Perfectly clean, and especially unsized paper, refuses color like the prepared stone, when it has been wetted thoroughly so that it is saturated. But here, too, mere water is not a complete preparation. Under strong

pressure it is forced away readily from the paper, the printed places are dried and the color adheres. If the pressure is not sufficient to force all the water away, the impression will be imperfect. The tougher the printing-color is, the more will it resist the dampness and the greater must be the pressure.

Experience has taught me the following:—

(1) Every paper not spoiled with fat will permit itself to be prepared, like the stone, with water so that it will take no color. In the case of entirely clean, unsized paper, water alone is sufficient. Mucous, gummy, and acid substances increase its power. Unsized printed paper need merely be dipped in water, laid on a stone, and coated with oily color, and the printed parts will all take the color while the rest of the paper remains white.

(2) Any great pressure will remove this preparation and the whole paper will take color.

(3) The oil color must be very thin and fluid, because a tougher one will take hold of the fibres of the paper and tear them off.

The foregoing experiences applied to the theory of the print itself lead to the following conclusions:—

(*a*) The paper to be used for printing must never be too wet, because the most powerful pressure could not remove the water sufficiently.

(*b*) Paper that is too wet is prone to adhere to the stone with its printed parts, which are likely then to tear away easily, thus damaging or ruining the work. This happens the more readily if the pressure be not sufficient. If the scraper or the stone is not uniform and even, it is very prone indeed to tear at the places subjected to the least pressure, because there, where the water has not been sufficiently squeezed away, the paper remains soft and fragile, while the pressure still is great enough to grip the fibres of the paper.

(*c*) Therefore the paper must be only slightly dampened if the color is very tough, partly to prevent tearing, partly to oppose no undue obstacle to the reception of the color.

(*d*) Paper dampened too much stretches in printing and produces uneven and dirty impressions.

(*e*) The quality of the water is not important so long as it is not dirty or putrid, in which latter case it may infect the paper and rot it.

(*f*) Just how much the paper must be dampened can be learned only from experience, because papers vary very much and in the case of sized papers it depends chiefly on the kind of sizing. On the average, we may calculate one wet sheet to eight dry ones in sized papers and one wet one to ten or twelve dry ones in unsized papers.

The following is the best way to dampen paper: Lay two or three dry sheets on a straight board. Then dip a sheet into water. Let the water drip off a little and lay the damp sheet carefully on the others. Now lay eight or ten dry sheets on top of this. Then put on another wet one and then eight or ten dry ones and so on till all the sheets destined for printing have been so piled up. Put over all a board weighted with a medium heavy stone plate. After half an hour increase the weight to several hundredweight or squeeze the paper in a press. Leave it thus at least twelve hours. Then it is generally ready for print. In aquatint it must be dampened more, about six dry sheets coming to one wet one.

Very thoroughly sized paper is easier to moisten if each sheet, or at least each second one, is wetted with a sponge.

Sometimes it is necessary to turn the dampened paper in order to remove the creases. Separate the sheets into two piles and lay a few sheets from one to the other so that the altered positions will press the sheets flat again.

With many papers, especially the unsized, it is possible to use the method of book-printers, who immerse a whole book in water and then lay the sheets in two equal parts. This would be best studied at a printer's. It requires much practice.

If dampened paper is permitted to lie some hours without being weighted down, the margins will become too dry, and then there will be creases during printing, which can be remedied only by a second dampening. The reason is that dry paper is not so large as wet paper, so that the dry margins form a kind of frame which is too small for the inner wet portion.

In printing-processes that require many plates, and especially if the sheets are large, only dry paper can be used, as otherwise the register will be imperfect. To be sure, it can be done by using great care, but too much practice and attentiveness is needed.

With the exception of the aquatint processes, good printing can be done with dry but unsized paper. But the press must have twice or thrice the pressure. This makes the printing more difficult and endangers the stone if it is not thick.

CHAPTER VI

PRESSES

An exact description of all presses used hitherto for lithography would demand a book that would nearly equal the present one in magnitude. Many drawings would be necessary, which would increase the cost of this text-book without adequate benefit, as I have learned that one rarely can find a mechanician skillful enough to make a machine even when he has the very best description and a perfect illustration before him. I advise all who intend to enter lithography to send for a model to Munich or some other place where the art is being practiced with success. I myself am willing to furnish exact models for the price of one louis d'or, which must be remitted with the order.

There is no press as yet that is so perfect for lithography that it leaves nothing to be desired. The press whose plan I laid before the Royal Academy of Sciences in Bavaria, which does its own inking-in and which can be worked by water-power, has not yet been built on a large scale, so that its value cannot be stated exactly.

I am only too well aware, however, of a grave defect in lithography, which is that the beauty and even the number of impressions depend mainly on the skill and the industry of the printers. A good press is necessary, to be sure; but even with the best a poor workman will produce nothing but trash, because in this respect lithography is far more

difficult than any other printing-process. I shall not admit that lithography has made a great step toward the utmost perfection until the erring work of the human hand has been dispensed with as much as possible and the printing is done almost entirely by machinery. Therefore I am determined to realize the ideas I have in this direction and I shall inform the friends of the art of my success at once.

I

PROPERTIES OF A GOOD PRESS

It has been observed that inscriptions, and particularly drawings, look better on the stone than on the impression afterward made from the stone. Partly this may be due to the color of the stone which softens the picture, because an impression made on yellow paper resembling the stone color looks very much like the drawing on the stone. But the great cause of the difference is that the color does not transfer itself to the paper with the degree of strength and clearness that it possesses on the stone. That this perfect degree can be attained, none the less, there are many successful impressions to prove.

If the plate is well designed and well prepared, it will take the color well and clearly, but the printer may apply too much or too little, the color may be too hard or too soft, or, even if the stone is properly inked, the paper may accept color poorly or be too damp or dry. Chiefly, however, it is the press, according to my experience, that most affects the quality of an impression.

In most lithographic presses the printing is done by the so-called scraper. This is a thin slat of hard wood, mostly maple, pear, or boxwood. It is one line thick on the side intended to do the printing, and the mechanism of the press forces it on the paper, which is on the stone and covered with an overlay of waste paper and tensely stretched leather. This pressure forces the color against the paper along the whole length of the slat, and only one line broad. The scraper is forced bit by bit over the entire plate, or it remains motionless and the plate is drawn underneath it.

It will be observed that this kind of press does not produce the entire impression vertically and at once as in book-printing, but that it is successive, as in copper-plate printing, with the difference that the copper-plate press uses a roller instead of a scraper.

As the scraper must be pressed down with great force (often as much as sixty and more hundredweight) and must pass over the leather with this immense pressure, there is a tremendous friction, and despite the fact that the leather is tensely stretched and lubricated with fat, it is considerably pulled and strained by the scraper. This pulling and straining communicates itself to the paper under the leather. Thus all the lines of the design become a little bit squashed in the direction described by the scraper. If, however, the leather is very good and very tensely stretched in the frame, if it is well lubricated, and if the printing-paper with its underlay is not too wet, the pulling is inconsiderable so that scripts and drawings in broad effects are not affected noticeably. Drawings in detail, however, and crayon work wherein there is hardly a perceptible space between the dots, are so affected by the slightest displacement that they produce a smeared, sooty impression.

The scraper has a second fault. If the paper has impurities, it injures the scraper readily. A groove scratched into the scraper will prevent any further good impression if the injury is considerable, because it will leave a streak. The only remedy is to take the scraper off and plane it, fashioning it accurately to the surface of the stone. I have tried to remedy this by making a scraper of metal. As this causes even more friction than wood, I laid a strip of strong paper over the scraper, which generally was good for three hundred impressions before it was worn out. Then I merely needed to move it forward a bit; so that a strip of paper as long as the scraper and six inches wide was available for some thousands of impressions. The pressure attained with a metal scraper is greater than with wood; but it has the disadvantage that it is hard to print a stone whose surface is not absolutely level, whereas a wooden scraper can be planed to suit any irregularity in the stone.

The foregoing shows that a good lithographic press must have these two properties:—

(1) It must not pull or shift the paper in the least.

(2) It must produce a uniform impression without weak spots or streaks.

The other properties it needs in common with other presses, such as: —

(3) It must be powerful enough to produce the necessary pressure.

(4) It must combine the greatest possible speed with this power.

(5) It must be easily operated, to save the workman.

All these qualities combined are not to be found in any press hitherto applied to lithography.

II

APPLICATION OF BOOK- AND COPPER-PLATE PRESSES TO LITHOGRAPHY

If we consider the peculiarities of book and copper print, we find a decided difference between them that affects printing importantly.

The letters of book-type are raised, the engraving in copper is depressed. It is evident that the former requires no such power for making impressions as the latter. Therefore the presses are so different that copper plates cannot be printed on a book-press and vice versa. Now, as the stone combines both the elevated and the depressed principles, the natural idea would be to combine the fundamental principles of both presses as nearly as possible for stone-printing. In book-print, only the types are exposed to the pressure, and in the average printed sheet these are only one fourth part of the entire surface. The remaining white space is not affected at all by the press. In the stone, however, the elevation of any part of a design is so slight that the entire surface is affected, and consequently a stone plate offers four times as much resistance. A book-press therefore would print a stone only if it were arranged for a pressure four times greater. Now, for a stone of the size of a letter-sheet the power required to print with one vertical pressure would be five or six hundred hundredweight, a pressure that could be supported only by a thick stone laid very exactly on a perfect foundation.

An ordinary copper-plate press increases the pulling of the paper so

much in the case of a stone plate that the impression would be worthless. This pulling is not caused, as in the case of the scraper, during the impression itself, as already described, but it is caused before the impression through the endeavor of the cylinder to force the plate along under it. Once the stone is under the cylinder, the paper is not pulled noticeably, because the cylinder glides over the leather much more gently and with much less friction than the scraper.

This defect might be corrected: —

(*a*) By supporting the cylinder so that it would come down on the stone only at the point where the print is to begin. But as the stone must be drawn pretty well forward for convenience in inking, this would demand that the cylinder be revolved forward and backward again as far as is needed for the impression, which means a great demand on the strength of the printers, not to count the loss of time.

(*b*) A second way would be to plane off a piece two inches wide from the cylinder at the point where the impression is to begin. The stone could be forced under this space readily, and when the cylinder revolves, it presses forcibly at once without pulling the paper very much.

(*c*) The press might be fitted with iron wheels with cog teeth to engage similar cogs on the cylinder. This would prevent pulling, but the mechanical work would need to be very accurate.

(*d*) The best arrangement will be the following: Set the upper cylinder so high that the stone can be brought under it without touching. Then bring it down with a screw, or better still, with a lever that can be operated by the foot.

The first figure in the plate showing presses represents about how a copper-plate press is to be fitted for this work. On the whole, this is an ordinary copper-plate press, but the upper roller is set with its two axles or spindles in two iron levers, each of which is fastened to a piece of wood with iron screws one inch thick. Each of these pieces of wood is covered with strong sheet iron and can be adjusted higher or lower with two screws or with underlay of pasteboard. This is necessary that the press may be adjusted to varying pressures. The two other ends of the

two levers, in which the cylinder sits, can be raised or lowered, so that the cylinder also can rise or sink. Now two springs or two weights are so adjusted that the cylinder with the levers always remains elevated. To force it down on the stone, an iron beam enters both sides of the press with two pegs so adjusted that when the beam is turned ninety degrees the levers are depressed at least two inches. As the cylinder is about in the middle of the two levers, it will thus be depressed one inch, which suffices to permit the stone to pass under it freely while it is elevated and gives the greatest pressure when it is depressed. However, the upper cylinder must not be one inch distant from the stone, but at the most only one fourth inch, for the remaining space of three fourths inch is required to provide margin for the elasticity of the various materials, and also to give margin for increased pressure whenever demanded.

On one end of the iron beam with the two pegs is an arm or lever which is joined to a thin stick with a treadle. This tread is so arranged that it remains elevated of itself. If the pressure is to reach sixty or more hundredweight, it must not be fastened directly to the treadle, but a second lever is required which is affixed to the side of the press.

Without going into tedious detail I cannot further describe this press. Mechanicians will understand me readily and perhaps be able to add many improvements. My belief is that a copper press so arranged would diminish all danger of squashing and pulling the impression, furnish powerful pressure, permit overlays of felt or fine cloth, and make possible considerable facility and celerity, which is a great advantage, because impressions always are better if too much time is not lost between inking and printing.

To safeguard the stone against cracking in such a press, the following points are to be noted:—

(1) The stone must be ground very true on the under side as well as the upper.

(2) Both cylinders must be perfectly true, and care is to be taken particularly that one cylinder is not thin toward the middle and the other thick, as this would easily crack the stone lengthwise.

The board on which the stone rests must be equally true and uniformly thick. At the same time it must be very thin, only one half inch thick at most. It will get very heavily squeezed during the printing, and the more the impression approaches the centre, the more concave will it become. The parts farthest from the point of pressure then resist unduly if the board is thick, and thus become the chief cause of cracking the stone. If the rollers are very true and the stone is very uniform, it is almost impossible to crack it if it is passed between the two rollers without a board underneath. If the board is thin, it is as if it were not there.

I believe that competent mechanicians can improve the present presses greatly.

III

LITHOGRAPHIC PRESSES USED HITHERTO

Most owners of lithographic printeries have tried their hands at inventing presses, but in the end it has always been something based on the scraper or the cylinder principle. I myself have made more than twenty designs. Some were very useful and had advantages either in power or convenience, but generally were handicapped by some defect, so that I cannot even say with certainty which was the best of them all. So much depends on the mechanic's execution of one's plans, and a perfect design can be so spoiled by a workman that it is worthless.

I will, however, recount the best that has been done so far for lithography.

In Munich two kinds of stone presses are mostly used. They are:—

(1) The lever press, or, as the workmen generally call it because of its form, the Gallows Press.

(2) The Cylinder or so-called Star Press, the latter term being used because a star-shaped lever is commonly used instead of a crank to turn the rollers.

I have tried and found good the following:—

(3) A press with double levers.

(4) A gyrating or sliding press.

I know also —

(5) The roller press used by Herr Andre.

(6) And the press of Herr Steiner in Vienna.

Herr Müller in Karlsruhe and Herr Ackermann in London have a press with paper cylinders the construction of which is unknown to me.

IV

THE LEVER PRESS

This was the first press that I used with advantage, and it is used still in Munich in all important establishments for work that demands speed particularly. It would be an excellent printing-machine in all respects if it did not have the defect that its power cannot be increased much more than six hundredweight without forcing the workmen to undue exertions. Therefore it is no longer available for large plates or for works that require immense power. It is very good for pen designs not larger than a letter-sheet, and two workmen, one to ink-in and the other to print, can produce twelve hundred impressions in a day without hardship.

The pressure is produced by a lever six to twelve feet long, fastened to the scraper below and to a spring (an elastic board) above. It is connected with a tread, and when forced down, presses with the desired force on the scraper and so on the plate. The board holding the lever overhead must be partially movable like a spring because the lever describes a part of a circle on the plate below. Hence the pressure at the beginning and end of the impression is not so great as in the middle, and great care in choice of wood and manufacture is demanded to give the spring board the necessary elasticity and power combined. I have found a board of young dried pine the best, the dimensions being six feet long, eight inches wide, and two inches thick, provided that the fibres all ran lengthwise. It is not always possible to find a good board at once. Often I have found that the difference between two boards made a great difference in the effectiveness of two presses otherwise exactly the same.

The scraper arm consists of two parts, of which the shorter one, to which

the scraper is fastened with a screw, is only one and one quarter feet long. The other part is as long as the height of the press permits. The higher a lever press is, the better is it, because then the circular motion described by the scraper wood approaches a straight line more and more, so that the press exercises a more uniform pressure during all stages of the impression and is easier to handle. The second illustration shows this kind of press in the moment when the impression has been finished, the printing-frame opened, and the scraper arm swung back again.

The printing-frame is much like a book-printing frame, and is furnished inside with a second small frame which holds the paper, being furnished with small springs or strings. When the frame has been turned over the stone, the paper must be at least half an inch from the stone to avoid smutting, which will occur if it touches. The paper must not touch the stone till pressure is applied, and then only on the spot pressed downward by the scraper.

As soon as both parts of the scraper arm are in a straight line, so that they form practically one piece, the scraper wood is pulled down and the printer draws it toward himself over the printing-frame and the stone plate. At this time the following is to be observed: —

(1) Both parts of the arm must be so fastened to each other that they may be bent like a knee, but once they are straight in line, they must stay in that position. It is well, therefore, so to adjust the parts that they will not be directly over each other, but rather exceed a straight line under pressure, and bend a little inward. The position of the scraper must be considered also. On the whole the following rule holds good: the point where both parts are united with a nail or a screw must not be in a perfectly straight line between the point where the scraper rests and the point where the arm is fastened above, but should be at least two and a half inches forward of that point. Otherwise the arm may spring outwards toward the workman and injure him severely. The third illustration shows the construction of the scraper arm and the scraper.

(2) The arm must be grasped as low as possible when being drawn toward one's self, in order to diminish the danger of springing outward.

(3) The workman must press his body tightly to the table of the press to get proper leverage. Standing free, a man of moderate strength could not move the scraper at all when the pressure is on, but a man standing in correct position can do it without difficulty.

(4) Under very heavy pressure the inker-in, who stands on the other side of the press, can help by pushing.

The scraper is a piece of pear wood as long as the size of the plate demands. Its height is about four inches, its thickness one inch. The end that rests on the leather is trimmed down so that it has a thickness of only one line. This end must be especially true and planed to fit the stone, also neatly rounded off. It should be so fastened to the arm that it may be adjusted to the position of the stone. The stone does not always lie truly horizontal in the press, sometimes because it is not uniformly thick, sometimes because the underlay is not quite even, and sometimes because the press itself has been a little strained. If the scraper has been made properly, it will adjust itself to the stone, even if the scraper arm is not quite plumb on the stone, a condition that often occurs with small work, such as titles and other things that are at the end of a stone.

(5) For every press a number of scrapers of different dimensions must be in stock. Generally a lever press is so made that the printing-frame can be raised or lowered according to the thickness of the stone. Then the scraper must be changed accordingly.

(6) The connection of the upper board with the tread is made by a thin stick that is fastened to a lever below, by means of a small iron piece which contains several holes that serve to adjust the height of the tread according to need.

(7) The leather in the printing-frame is strong calfskin. It must be stretched very evenly and tensely and must be smeared from time to time very thoroughly with tallow.

(8) On the outer side of the frame there are four wooden strips that can be adjusted as desired. One serves to show the point where the impression is to begin. Another shows where it is to end. Both must be so strong that they can resist the scraper. The other two are adjusted at the sides and guide the scraper.

V

THE CYLINDER PRESSES

When Herr Professor Mitterer installed a lithographic institution for the Feyertags-Schule, the lever press appeared to him to demand too much labor, especially when powerful pressures were desired. He invented the so-called Cylinder or Star Press, which has its place in most establishments, especially those in other countries. It has had minor changes made in it by many persons, but on the whole, nobody has succeeded in improving it notably, except for a considerable improvement made by Herr Mitterer himself. My description will include this improvement.

The cylinder press might almost be called a reversed lever press. Herr Mitterer borrowed from it the idea of effecting the impression with a scraper, but he did not let it move over the plate, as in the lever press. He gave the scraper a fixed, immovable position while the stone was drawn through underneath, thus making his press resemble a copper-plate printing-press somewhat.

Illustration number 4 shows this machine in the moment when the impression has been made. In the middle of the machine is a cylinder ten to twelve inches thick and as long as the breadth of the press. It has strong iron spindles that revolve in well-lubricated brass bearings. Above the cylinder is a board on which is fastened the stone with the printing-frame. The scraper is on a strong lever that is held up by a counterpoise. When everything is ready for printing, the scraper is forced down. By means of a strong iron hook it engages the treadle and thus can be pulled down with the utmost tension. Then the cylinder is turned by means of two levers affixed to the crank, and this draws the stone and printing-frame through under the scraper. One workman alone can do this under ordinary pressure, but an appliance at the other end of the press enables a second workman to help.

VI

GYRATING SCRAPER AND DOUBLE LEVER PRESSES

I have already mentioned the gyrating scraper press. I have improved it considerably. It has the form of the ordinary lever press, but all the parts can be much lighter. For instance, the lever is only one and a half inches thick. The spring (the elastic board) is very elastic and need exert a pressure of only one hundred pounds. The little scraper is only an inch long and presses on the plate with a force of fifty pounds. The press is useful for very thin stones that might crack under greater pressure. The pressure, nevertheless, is great, because it is all exerted on such a small area. The press has two defects. It is easy to miss many parts of the design with the small scraper, and the paper is likely to stick to the leather, producing poor register. I have obviated these faults with the following invention: A large scraper is fastened to the lever to press on the plate with a force of one hundred pounds. A small one is fastened to this in such a manner that it can be moved to and fro easily. While one workman rubs to and fro with the small scraper, another draws the entire stone and printing-frame slowly along under the large one. If good underlays are used in addition, this process will produce beautiful work that cannot be produced so well with any other machine. However, a large field is left in this form for improvement.

The fact that the concentric motion produced by a single lever can be transformed into an almost straight motion by use of a second lever, led me to design a double lever press, which has turned out very successful, giving great force with speed. As its description would demand much space, and since on the whole it ranks equally with the improved cylinder press, I offer to send models to those who desire to have everything useful for the art.

VII

THE OTHER STONE PRINTING-PRESSES

The cylinder press of the Chemical Printery in Vienna would, without question, be of excellent service for the art if it were more powerful. Its construction is as follows: The stone is fastened to a table with the printing-frame which has fine felt instead of leather. To make the impression a brass cylinder eight inches thick is rolled over it. As this cylinder would not produce enough pressure from itself, despite its massive make, two iron beams are fastened to the axles. They pass through the table and are fastened to a box that contains iron or leaden weights. Unfortunately the space prevents the use of more than five or six hundredweights, and this is too little for the large surface of the cylinder, thus forbidding any sharp, clear impressions.

This kind of press could be greatly improved if it were built higher to give more room below for weights, or the beams could be lengthened and passed through the floor into a lower room, thus giving space enough to add weights up to fifty and more hundredweight.

The press of Herr Andre is much like this, except that its cylinder is only three inches in diameter and that it is forced on the stone not with weights, but with a lower cylinder that presses upwards. It prints fast, like the other, but does not possess enough power.

In conclusion, I must remark that the concentration of ideas caused by writing this chapter has led me to begin experiments toward making a lithographic press which shall leave nothing to be desired. As soon as my affairs permit, I shall execute this on a large scale, and if the result fulfills my hopes, it will be a pleasure to describe it accurately to all friends of my art, or to furnish them models at cost.

PART II

CONCERNING THE VARIOUS METHODS

THERE are two principal methods of stone-printing, Relief and Intaglio.

In the former, the fatty parts of the stone are not attacked by the etching fluid, while the rest of the stone is dissolved more or less. Therefore the fatty places are left in relief.

In the second method, the design is either engraved into the stone with a sharp steel instrument or etched-in with acid.

The relief method has the advantage of greater speed and, generally, a greater number of impressions. It is easy for the artist to apply, especially in crayon work. The intaglio, however, makes possible finer and more powerful work, and again, in many cases, is the easier of the two for the artist. Therefore it is impossible to say in a general way which is the better. It depends on the work to be done.

CHAPTER I

RELIEF METHOD

To this method belong principally: (*a*) Brush and pen designs; (*b*) the crayon method; (*c*) the transfer method; (*d*) the wood-cut method; (*e*) a sort of scraped style; and (*f*) spatter-work.

I

BRUSH AND PEN WORK

This is one of the best in lithography, and perhaps the best, because it touches daily needs most directly. It can be used not only for all

kinds of writings, but also for illustration that does not demand the supreme perfection of copper plate. The ease of manipulation, the speed and the almost countless number of impressions recommend it especially. It may even be prophesied that in future, when true artists have become better acquainted with it, it will be used for high forms of art.

Much as this method has to recommend it, it has been used mainly for script and music, and it is difficult to gain adherents and followers for it. The reason is an apparently trivial thing, but it has made most artists averse to it. Since stone-printing exists I have found only two persons who could do anything with the steel pen at the first attempt. These were my brother Klemens, and a Herr Porner, who works now in the establishment of Herr Müller in Karlsruhe. All others have had to struggle more or less with this slight trouble, and yet it does not demand more than a few days of patience and study.

For pen work one must not be too particular in selecting stones, as the less perfect ones are more available for this than for any other method. However, the general rule holds good here, too, that the purest and hardest stones are best.

If they have been used previously, so that the fatty inks have penetrated pretty well, they still need not be ground too deeply, but it will suffice to grind them merely till all depressions and elevations of the previous design have vanished. They may be ground with sand or pumice, so long as they are made smooth so that no roughness can be perceived. The smoother and finer the surface is, the easier will it be to work on it with the pen.

To design well on stone with chemical ink, the stone must be prepared after grinding so that the ink shall not flow and spread. Dissolve one part of tallow in three parts of oil of turpentine and coat the dry stone very quickly. With a clean rag or tissue paper wipe it at once so thoroughly that the coating vanishes again almost entirely, leaving only a thin film that can be easily devoured and removed when the etching fluid is applied later. It is well to do this some hours before beginning work

on the stone, partly to give the turpentine odor time to evaporate and partly because it is easier to work after a little while than immediately after coating the stone. The stone can be prepared far in advance, even so long as some months before using. In that case it is necessary merely to clean the dust away with a cloth or fine brush. This should be done anyway at intervals during the work, or it will clog the pen.

I prefer another way of preparing the stone for designing, because it is one that insures the stone against containing any hidden preparation, which can easily occur in grinding owing to carelessness or uncleanliness on the part of the workman, especially if many old plates are being re-ground, when the gum which most of them contain from previous use will mix with water during grinding and thus form a partial preparation of the stone.

I coat the plate with strong soap-water containing many soapy particles, and dry it off as well as possible. Now, there will be too much alkali on the plate, which will not be good for fine work. I pour a few drops of clean water on the stone, make it quite wet with this and dry it again thoroughly. The fat of the soap will then have precipitated itself on the stone and at the same time has lost all alkali. The soap-water must not be too thin, as in that case it will precipitate too much fat on the plate at once and the etching fluid will not be able later to destroy it properly. This would mean the total destruction of the design. To make quite sure, I advise beginners, after applying soap-water and drying it, to coat the stone with the tallow and turpentine solution, clean it quickly, and thus be absolutely assured that the plate is thoroughly prepared for the design.

It must not be imagined that this preparation for work is not very important. I am convinced that less depends on the quality of the ink than on a surface freed from all acid and mucous substances and provided with a sufficient amount of fat.

On the stone thus prepared the rough design may be done with lead crayon or red chalk or by tracings or transfers. Any surplus of lead or red chalk would make trouble during the succeeding completion of the design with chemical ink, and must be removed carefully. If the design

has been laid on by transfer, the resultant fattiness must be lightly rubbed away with a fine sand, but not so as to injure the design.

This method, of first drafting the design on paper with soft chemical transfer ink and then transferring to stone, offers such advantages that it pays to practice it. Care must be taken to remove all surplus of color, as otherwise all lines that should not appear will resist the etching fluid and gradually show again. Those who fear destruction of the design by the use of sand can effect the same purpose by printing off on clean waste paper a few times, or the design may be printed off on paper before being transferred, thus cleansing it of surplus fat.

When the design has been laid on the stone clean and strongly with chemical ink, the plate can be etched and prepared, but not till the whole design is perfectly dry, because otherwise it cannot resist the action of the fluid.

The parts finished first usually are dry long before the entire work is finished. A trained eye can recognize the proper degree of dryness from the sheen, which varies with different kinds of ink, but on the whole is always duller when the design is dry than while it still is wet. It is highly necessary that the design be thoroughly dry. It is possible to keep a designed plate for years without etching it, so long as it is protected against injury.

Etching is done in two ways, painting the fluid on and pouring it on.

The former method is less circumstantial, but is used only in coarser work, because there is always danger of damaging delicate parts of the design. It has the advantage, however, that any dirt caused by corrections will be removed. A mixture of three or four parts of water with one part of aquafortis is painted over the stone with a soft brush of fox- or badger-hair. The brush must be dipped continually because the fluid loses its power.

For the second method the stone is placed in a large wooden trough or box, provided with cross-pieces to keep the stone from the bottom. The acid, thinned down with thirty or forty parts of water, is poured over it. It is rather immaterial how much one may dilute the acid. Very weak

solutions simply mean that the pouring must be repeated oftener. The fluid acts on stones according to their degree of hardness. Regard must be had, too, to the delicacy of the design, very fine lines being unable to resist etching that does not affect coarse lines.

Only slight experience is needed to recognize the effect of the acid. By looking at the stone sidewise and against the light, the growing elevation of the design can be perceived easily. When the fatty coating caused by the soap or turpentine wash has been etched away completely, and the water adheres equally everywhere, the stone generally is sufficiently etched to be ready for preparation and printing.

For the sake of easier printing, and also so that future grinding and any desired improvement may be done on the stone, there should be a little more etching, if the design is not too delicate. But if the design is very fine, the etching absolutely must not be more than strictly necessary, because the fine lines might easily be eaten away. Coarser designs can bear strong etching which often may reach the depth of a thick paper. But an inordinate amount of etching is not to be recommended, even if the design can bear it, because the edges of a deeply etched line are rough and take the color so strongly that it works into the cavities and is very hard to get out.

When the stone has been properly etched, clean water is poured over it to wash away the free acid. Then the work of preparing the plate with a solution of gum arabic in four or five parts of water can begin at once, or the stone may be set aside to dry, thus giving the finer parts of the design, that may have been most affected by the acid, time to adhere again to the stone and soak in, which can occur only in the dry state. This is entirely unnecessary with most pen drawings, but with brush and especially with crayon work it is of great value.

When the stone has been prepared with gum, it is set aside to rest for a few minutes. Then pour a few drops of water and exactly the same quantity of oil of turpentine on it, spread it in all directions uniformly and wipe the entire design off clean with a woolen rag. Hard ink, especially if it has been on the stone for some time, is more difficult to remove and a little more turpentine is required.

The stone should now be inked-in at once, because the turpentine, and with it all the fattiness, is liable to extensive evaporation, and then the stone will not take color well.

Inking-in of the pen designs is done as follows: A clean linen or woolen rag is soaked in clean water and wrung out till it is damp rather than wet. This is passed over the whole stone so that it becomes a little wet everywhere. Immediately after this dampening, the well-inked printing-roller is passed to and fro over the plate several times. The roller must be lifted frequently during this work so that the points of contact change. To lay the color on well and quickly, the roller should be held rather firmly in the beginning, well pressed down and used with a certain rubbing motion that will tend to lay color on the design sideways, so to speak. Then the roller must be allowed to roll to and fro a few times without much pressure, to spread the color and take away any surplus. Do not roll too long, till the stone dries, because then it will take dirt immediately. Should this occur, it must be wiped instantly with the damp cloth till it is clean again. If dirt is left too long, it will be extremely hard to remove.

Beginners usually wet their plates excessively to counteract this trouble of drying during the inking-in. This results in wiping away fine strokes, and the roller gets so wet that no good impression can be made till it has been dried sufficiently again. For this reason beginners should not use bath-sponge, because, though it is excellent, it leaves too much water on the stone unless one knows exactly how to use it.

Some printers put a little gum, others a little aquafortis into the water to wet the stone. Others use stale beer, or even urine. I consider all this unnecessary, if the stone has been prepared correctly and the color is good.

I have described the ink-rollers. I repeat that they must be uniform, soft, and elastic.

As to the inking-in color, I am not able yet to lay down a strict rule. All that I can say, as a result of my experiments and experiences, is:—

(1) The firmer the varnish in a color is, the cleaner is the work of inking-in.

(2) The same is true the more lampblack it contains.

But in both cases the finer parts of the work are easily rubbed away, and too much lampblack makes the lines squash the impression.

(3) The toughness or fluidity of the color must bear correct proportion to the power of the press. The harder the varnish, the more power is required in the press.

(4) Tough varnish is not so liable to squash under pressure, but if it has once been pressed into the spaces between the lines of the design it is not readily removed by the mere action of the inking-roller, and this causes more and more smutting and, finally, total ruin to the stone. Generally when a tough color has adhered too much, there is no other remedy than to clean the stone well with gum and oil of turpentine; and this, if done too often, damages the preparation and makes the impressions continuously poorer.

(5) Soft color spreads more readily under pressure, but is removable after each impression by merely dampening the plate.

(6) In using soft color, the paper may be kept damper than with hard colors.

(7) Soft as well as hard printing-color, if not mixed with the proper amount of varnish, has the property of producing poor, sooty impressions because of a defect called shading. Shading is caused as follows: If a drop of oil falls into a basin of clean water, a part of the oil will spread immediately. Now, a stone is wetted before inking-in. After the inking a considerable portion of dampness remains. If the ink is very fluid, it will happen often that a part of it will spread away from the design to the surrounding moisture, producing something that looks like a shadow around every part of the design. This does not occur instantly, as in the case of the pure oil, but gradually, so that it is not as noticeable when the swifter lever press is used as with the slower cylinder press or if the workmen are slow. If a stone can be dampened so exactly that with the last touch of the ink-roller the last vestige of dampness is removed, this

is not likely to happen. But it is difficult to arrive at such accuracy. It is better to add enough lampblack gradually to the varnish to make it lose its elasticity, when the shading effect will cease.

(8) While shading is obviated largely through enough intermixture of lampblack or other coloring substances to take away the fluidity of the printing-color, this intermixture will cause other troubles. The finer places will not take the harder color so well, whereas at other places too much will be taken. Also an impression made with much lampblack will off-set more than one made with color in which varnish predominates. Neither will the impressions be so black. Experience teaches that a printing-color that has less lampblack will be blacker, because the sheen of the varnish will make the color strong and lacquer-like. I have tried to invent a kind of varnish that would not be so liable to shading and thus would permit a greater fluidity with safety, but lack of time has prevented me from exhausting the possibilities. I am sure, however, that it can be done, for I have found that the common linseed oil varnish can be made to lose its property of shading by admixture of fatty and resinous bodies. For instance, the addition of a slight amount of Venetian turpentine permits a greater fluidity. Very good is the following composition: Six parts linseed oil, two parts tallow, one part wax, melted together and thickened by boiling down and burning like the ordinary linseed oil varnish.

(9) The inner composition of the stone and the temperature have a considerable effect on the print and also react on the color. A stone, especially a porous one, has much less internal moisture on very warm, dry days. Then the dampening done before each impression often evaporates instantly and unequally, so that it is difficult to ink-in uniformly with a soft color or one lacking varnish, unless one wets the stone unduly, which, again, injures the impressions. In that case one must use a color that is firmer than should be used according to ordinary rule. It is also well, before printing from the stone, to lay it in clean water for a few hours, or overnight, so that it may soak in enough moisture to make it easier to dampen.

(10) If the drying of the printing-color is to be hastened, as is neces-

sary with some work, a little finely powdered mennig may be mixed in. Finely powdered litharge of silver dries still better, but only a small amount of printing-color must be mixed with it, because it toughens within an hour. It will not keep for another day, because the mennig will dissolve after a while.

In printing from the pen design, the following must be observed:—

Even if the stone has been inked-in uniformly and well with a good color, the impression can be spoiled in various ways: if the paper has not been dampened as required by the nature of the color and the power of the press; if the pressure is not in proportion to the consistency of the color; if the scraper is not even, and if the leather is not properly stretched.

Therefore care must be taken in printing pen designs:—

(1) The paper must not touch the inked design till the scraper forces it down. It is not advisable to lay the paper directly on the stone. It should be in the printing-frame, which, as already described, should be so arranged that it will keep the paper at least one fourth inch away from the stone.

(2) The proper dampening of the paper is not a matter of the greatest importance in pen designs, so long as it is not too wet, in which case it causes squashed impressions, does not take color uniformly, and, if the printing-color is tough, will stick to the stone. In general, the rule holds good that the degree of dampening must be in proportion to the firmness of the varnish, and that a softer varnish permits increased dampening. Dampening is done chiefly to soften the paper, and the qualities of the paper dictate the amount necessary to a large extent.

(3) The tension of the press must be more powerful with hard printing-color and carefully graduated with soft color. Besides this, it depends —

(4) On the structure of the scraper. If it is not absolutely uniform and well fitted to the stone, more power is needed. Thus the defect often is corrected; but this may make the color squash and spread in other spots, therefore it always is better to correct any defects in the scraper. The sharper the scraper is, the clearer are the impressions, because then the whole force of the pressure concentrates on the smallest area. But usually

the scraper soon becomes dull, and then the press must have more power.

(5) Insufficient tension of the leather also may produce poor impressions, especially if the color is soft and the paper very wet. Therefore as soon as impressions appear blurred and squashed, the leather should be tautened and well lubricated with tallow.

Now we come to an important matter, namely, the correction of errors. It does not happen often that a drawing or inscription can be made entirely without error, and it would be a great imperfection in lithography if these mistakes could not be corrected at once.

Errors may be observed before etching or afterward. Different ways of making corrections are required.

It is very easy to make corrections before etching. If the error is observed as soon as it is made, while the ink still is wet, it may be corrected by merely wiping out the defect with the finger. If the ink is dry, oil of turpentine is required. In each case the ink must be well removed so that it will not resist the etching fluid later. If only tiny spots are defective they can be corrected by delicate use of a sharp eraser. Defects that need merely to be destroyed without drawing anything else in their place may be scraped off with a knife or with pumice stone.

After the plate is etched, errors demand treatments that differ according to whether a defect or blemish is merely to be removed, whether something else is to be drawn in place of the removed part, or if something has been forgotten and is to be added. The area of the correction also makes a difference.

If it is only a matter of removing small defects or places, delicate erasure will do. The same, or polishing with pumice, is done if the area is larger. Then the corrected spots must be coated with a mixture of gum and aquafortis, using a soft brush very carefully that it may not touch any of the sound places.

If something new is to be drawn in, the process is different. Ink-in the stone very clean, and coat it with gum and water that is very thin and delicate. Let it dry. Then scrape the defective places away very care-

fully or grind them away by rubbing with pumice stone. Coat the spots cautiously with soap-water or oil of turpentine and clean off again as thoroughly as possible. (This coating is not necessary in the case of a few isolated small lines or points.) Now draw in your new design with chemical ink, and as soon as this is dry, etch the corrections carefully with a small brush and then prepare with gum.

The third case, where something has been forgotten, is treated almost the same way. If it is only a very small thing, the stone need merely be scraped carefully. Then the drawing may be put in, preferably with a thicker ink. If the area is large, the stone must be ground where the design is to be added, coated with soap-water or oil of turpentine, and then treated as explained before.

When the stone has been corrected and prepared for printing, it can be used at once or set aside for some length of time. In the latter case it should be inked with a firm color and coated delicately with gum solution. Then it can be held as long as desired. Coating with gum solution is advisable not merely for storing away, but for every interruption of printing that lasts more than five minutes.

If a stone has stood longer than a day without being freshly inked, it must be wiped off first of all with gum solution and oil of turpentine, that it may take the color well, so that the very first impression may be perfect. During the progress of printing, the following points are important: Uniform distribution of water, the same of printing-color, frequent inking of the inking-roller, and the very greatest speed possible.

In the main points the brush process is like that of the pen. The chief difference is that it is not possible to make the brush strokes as strong as those with the pen. Therefore, brush work does not resist etching so well and must not be treated too powerfully. Much depends on the treatment of the brush and the consistency of the ink. The brush does not permit such a flow of ink as does the pen, and generally requires one that is more fluid. A good brush ink is made as follows: —

Mix two parts of pure white wax and one part of good tallow soap into a mass not larger than a hazel nut. The ink loses its good properties

quickly and should be made fresh day by day. Mix the two materials with a thick knife on a lukewarm (but positively not warm) stone, separate into small parts and moisten with rain water. As soon as the water has softened the mass a trifle, add as much lampblack as will lie on two knife points and mix the whole mass together once more till it is thoroughly mixed and quite firm. When required, a bit of this is rubbed down in a clean saucer with rain water.

As a better flow of ink is needed for brush work than for pen work, it is evident that it would not be requisite to treat the stone with soap-water and oil of turpentine, as for pen work. However, it often pays to make certain fine lines with the pen, and therefore it is better to combine both processes and prepare the stone as for pen work. It is well, however, after drying the coating, to rub it very gently with dry sand, which will not make the pen strokes flow to any extent and still will prepare the stone so that it will take the brush strokes well and not make necessary such strong etching.

If a brush design is to be etched in high relief, for ease in printing or for durability, it must be etched only to the extent absolutely required at first. Then it must be prepared with gum and inked-in with good acid-proof color. Set it aside for a while, that the color may concentrate so that it will resist the acid well, and then etch the stone to the desired degree. After etching, wash with water, coat with gum and put aside to dry. Owing to this latter procedure any fine parts that may have been unduly affected by the acid will adhere to the plate anew and it can be printed then like a pen design.

If pen and brush work are to be combined on a stone, and absolute certainty is desired, that even the very finest lines shall not suffer from etching, the following process will serve: —

Over the cleanly ground plate pour a solution of weakened but pure aquafortis, about forty parts of water to one part of aquafortis. Repeat this several times. Then pour a great deal of water over the stone, to wash off all acid, and let it dry. Pen as well as brush work is easy on such a stone, by using the proper ink for each method. When the work is

finished and dry, the stone is merely coated with gum solution. After a few minutes it can be inked-in with acid-proof ink and treated as described before.

II

THE CRAYON METHOD

The fat of the chemical ink penetrates the stone in dry form as well as in fluid form, and makes the plate receptive to printing-color. If the dry ink is cut into long pieces and sharpened, it can be used much like lead or black crayon. If the stone is ground very smooth, the work can be made quite fine and resembles that done with fluid ink. The crayon, however, wears away too quickly. If the stone is ground rough, so that instead of a polished surface it has one resembling rough paper, the crayon work appears as a mass of dots that are coarser or finer according to pressure with the crayon, and produce an effect similar to crayon designs on paper. As almost every artist and painter knows how to use crayon, no particular practice is required for working on stone, and there are no obstacles such as the difficulty of using the steel pen.

That crayon work on stone is capable of high perfection, and that it can represent the essentials of a painting in a manner scarcely to be excelled by the best copper-plate engraver, has been demonstrated by many successful productions. Add to this that in no other style can one work equally fast, either on copper or stone, and we see that the crayon method is a genuine advantage for the art.

For crayon work the stones must be uniform and hard. They must either be new, or, if they have been used, they must be ground so thoroughly that all traces of fat are destroyed and removed absolutely to a degree where it is certain that they will not appear again and take color, even if the stone is etched only lightly. As soon as the plates have been ground true, they must be grained by strewing some fine sand or powdered sandstone on them and rubbing in all directions with a small piece of limestone. The work can be done dry or wet. Soap-water is best. It gives the stone a handsome grain. Practice is demanded to get good

results without scratching the stone. The artist must decide for himself what grain he needs. I think that it would be good if the artist himself were to grain the stone in varying degrees according to the need of his design. For instance, a coarser grain might be good for foregrounds.

As soon as the stone has been grained, it must be cleansed perfectly from dust and dirt. It is best to pour clean water over it and wash it with a clean rag. The dust and sand must all be removed, otherwise they will not let the crayon reach the stone where it is used delicately.

When the design is finished, it should be set aside for a day, that it may take good hold of the stone. It does no harm to let plates rest for years before etching. Etching must be done by pouring. Painting the etching fluid on is dangerous because of the danger of taking away fine spots. About one hundred parts of water are used to one part of aquafortis. Everything depends on not etching a bit more than necessary. It is best to etch the coarser parts specially with a small brush and stronger etching solution, and it is very good to wash the stone with clean water after etching and let it dry completely before coating with gum.

When the stone has been prepared, it should not be cleansed at once with oil of turpentine, but should be inked-in first with a light printing-color. Only after it has taken this well should it be cleansed of the crayon and treated to a firmer color. In the first inking-in there should be very little pressure with the sponge or wet cloth when dampening it, as the lightest parts of the design are easily rubbed away before they have taken color. If such parts should vanish, the easiest way to restore them is as follows: —

Coat the plate with gum solution and wipe with a clean dry cloth till it is perfectly dry. Then take a flat, knife-like instrument of steel, which is cleanly ground so that it has no nicks or other defects that might injure the stone. Scrape with moderate pressure to and fro over the defective places, but only so that it touches the elevated points and not the surface of the stone itself. Smear a little fat, such as linseed oil varnish, over it and wash this away again instantly with gum solution. Generally the parts all reappear very nicely when the stone is inked-in again.

A second kind of correction is as follows: Ink the stone with firm color, wash it well with plenty of pure water and let it dry. Now redraw the lost places with crayon.

Printing crayon work is the most difficult of all lithography, but can be done perfectly if all necessary precautions are taken. These are mainly: (*a*) proper dampening of the paper; (*b*) perfect dampening of the stone; — too much meaning that the fine points will not take color well, too little making the stone smut easily; (*c*) good stretching of the leather, industrious lubrication, and an underlay of taffeta; (*d*) a good, finely mixed inking-color that will not shade off in printing and yet does not contain too much lampblack; (*e*) soft and well-dried ink-rollers; (*f*) proper tension of the press; (*g*) utmost possible speed in printing. The latter aids enormously, because the stone does not get so much time to dry out.

Aside from the spreading and running-together of the darker parts, one of the commonest faults of crayon work is that it is very liable to get a tone, which spreads over the whole design like a veil; or that the designs lose their firmness and appear "monotonic" because the shadings spread and thicken. The first fault comes from weak etching or from oil that was rancid when it was used to prepare the varnish. The latter fault makes the color adhere and smut the stone. The same fault is developed if the printing-color contains soap, which some printers mix into it for better adherence. It can occur also if the stone has lost its preparation owing to frequent cleansing and strong rubbing with a dry rag that is inky. Even strong rubbing with clean water can cause it if the rag contains fats.

As to the "monotonic" effect, it is frequent, and I have learned that it can be caused in two ways, namely, if the color is squashed continually during the print, which makes the stone sooty; or if the color spreads, as, for instance, during the night or during the noonday rest. The stone is prepared only on the surface. In the pen style, all lines are prepared on the sides also, so that they cannot spread because they are considerably more elevated than the crayon designs.

If a crayon design dries after printing and is not coated properly with gum, the color is liable to spread away from the design and give the plate

the before-mentioned tone. Even if it is coated with gum, the color will spread, at least in the inner parts of the stone; and as soon as the very thin surface has been at all wiped away by rough usage, the underlying fattiness will appear gradually, and begin to take color.

Both faults of crayon work, namely, the taking of tone and the development of a "monotonic" condition, can be remedied by inking the plate for a while with a firmer color. If this does not help, the following must be resorted to: Ink in the plate as well as possible, lay it in the etching-trough and pour over it very weak aquafortis once or twice. Then wash it with pure water and paint the gum solution over it. The etching must be done with great caution, with a solution so weak that the acid is scarcely perceptible. If the plate is to be saved at all without extensive corrections and re-drawing, this is the best way. If it is done correctly, it harms the design so little that I advise it even when the plate looks quite well, but has been standing very long after the first printing.

I have etched several crayon designs over again, and rather extensively, to make them more durable and facilitate printing, and with good success. This gives the further advantage that corrections can be made at the same time.

The correction of crayon designs, that have been etched already and used for printing, always has been so difficult a task that few have succeeded. This has led me to give the matter my best attention; and I hope that the following rules, based on many experiments, will show the way, at least, even if they do not produce absolute results.

When a copper-plate engraver has partially finished his plate, he can have a proof pulled to enable him to study his work. Then he can make corrections as he pleases, — an advantage that the stone worker has lacked hitherto.

To produce an impression that shall be faithful to all the beauties of a crayon design is a matter dependent on so many trivial details that of the many hundred crayon designs that have been produced by lithographers since the origin of the art, hardly one has realized the designer's hopes and ambitions. The commonest fault is that the more delicate parts of

the design print too light and the heavier ones too dark, thus destroying the balance of tones. The lightening occurs because the finest parts of the design have lost their power of taking printing-color. The darkening occurs because the closely shaded parts flow together, either because the etching has not made enough white space between the points and lines or because they are squashed in the pressure of printing.

From this, two other faults may arise, that become visible after inking-in the plate: The first is the appearance of white dots, sometimes pretty large. The second is that black dots and smut-marks appear.

The white dots are caused by speaking during the work, and thus dropping spittle on the plate. If the spittle is mucous, the plate covers itself there with a fine crust that resists the chemical crayon so that it does not soak into the stone and is wiped away by the inking-in. If the spittle is fatty, — for instance, if one has eaten anything greasy, — the dots that appear will be black. The same results from touching the plate with fatty hands. Sometimes a whole picture of the fingers and skin will appear on the impression.

Let us suppose that after inking-in, a plate shows all these faults: the finest shadings vanished entirely, the darker places run together, white and black dots and smut-marks so that the plate has become useless in every respect. Can this be remedied? If so, how?

I answer that it can be remedied in every point; but that the artist himself must decide if it will not pay better to do the whole design anew.

The second question I answer as follows: —

Before everything else, it is necessary to remove all that should not be on the stone, all smut-marks and black dots; and where the design has darkened, white points or lights must be graved-in. To accomplish this, the stone is inked-in first with a firm acid-proof color, and over this with a lighter one. Then erase or grind away the dirt that is outside of the design and that would dirty the margin of the printing-paper. No erasing or grinding must be done within the design itself because then the grain would be destroyed and the necessary drawing could not be done as it should be. Therefore the faulty parts must be removed by engraving,

with a more or less sharp needle of good steel, so that what remains looks quite like a good grain. A little practice will show that this work is not at all difficult and can be done quickly. Places that have run together can be cleared and made transparent and clean in a few minutes. If certain points have become too large, they can be corrected by engraving a white point in their centre or by engraving a line through them.

Here I must note that parts of crayon designs thicken sometimes because the crayon has slipped in drawing, without leaving traces perceptible at the time. If the etching is weak, it may happen easily that this place takes printing-color. Skillful engraving may not only correct the defect, but actually gives the design a beautiful tone and power such as cannot be easily produced by the crayon itself.

When the plate has been cleansed thus of all surplus and blemishes, weak aquafortis is poured over it several times and then it is coated with gum. After a few minutes it is inked-in with fairly firm color. Then it will be seen that the design is clean, but that all the parts that were too light are not darker, but perhaps even lighter, having been affected by the etching. To remedy this, coat the stone with gum solution and then wipe it off with a dry clean rag so thoroughly that only a thin film of gum remains behind. To judge this better, it is well to mix a little red chalk with the gum. When the plate is wholly dry, take a knife-like tool of steel as described before, and scrape the defective parts under moderate pressure, without injuring the elevated points of the design. Great care must be taken during this process to let no moisture, not even the breath, touch the stone, because that would produce the very opposite of what is aimed at. When all faulty places have been treated, a little tallow or linseed oil is smeared over the plate and then washed away well but gently with thin gum and water. If this manipulation has been done accurately, the lost parts of the design will appear when the plate is inked with a somewhat softer color.

Those who fear that they do not possess the skill necessary for this rubbing-up of the defective parts may attain the object by re-drawing them. The stone must be washed off first with a great deal of very

pure water and the crayon must contain much soap. This kind of correction must be finished as quickly as possible and the stone should not be set aside for any length of time without a gum coating. If the corrections are extensive, it is better first to ink the stone well with acid-proof color and then to wash it in pure water and let it dry. Then if it is inked-in after the design is finished, and if weak aquafortis is poured over it and it is prepared with gum, it will keep for several months.

Slight blemishes, white specks, etc., can best be corrected by gentle touching-up with crayon during the proof-printing on the wet plate. It is understood, of course, that one can also work with pen or brush in a crayon design that has been already etched. Parts that are too dark can be made lighter by passing over them a few times with a brush dipped in weak aquafortis and then re-coating with gum.

These are about the best ways for correcting a crayon design that proves after etching to be imperfect.

I close with the following: —

(1) The tanners of Munich manufacture an inking-ball, made especially for printing, of sheepskin, such as I could not obtain in other places, like London, Offenbach, and Vienna. It is not white like alum-dressed leather, but yellowish, and the oil has not been completely washed out. I have had dogskin and thin calfskin worked in the same way and have found them even better, because of their greater durability. If a roller is covered with this leather, so that the side that was hairy comes outermost (not innermost as many do), it develops a decided property of taking-on color, probably because of its smoothness and elasticity. This aids much in spreading the color uniformly over the stone. The property is increased if the roller is dampened slightly before being inked; but on the contrary, if the stone is kept too wet, the constant moisture will gradually prepare the roller, so to speak, and it will take less color and let it go quickly, thus inking the stone badly.

If a roller has been used a long time, it loses its elasticity and softness and becomes useless for fine work. Still worse is a roller that has hardened from the drying of the ink. It is surprising to see what a dif-

ference it makes if one has worked for a time with a poor roller and then replaces it with a good one. It is almost impossible to believe that the new impressions come from the same stone. I am inclined, therefore, to believe that the quality of the ink-roller has more effect on good impressions of crayon and fine pen work than even the quality of the printing-color.

As stated, it is well to change rollers frequently, and it is wise to clean them with linseed oil or butter after use to keep them soft and tender. In working on crayon designs of superior value I advise the use of new rollers.

(2) It has been remarked before that the color of the stone often deceives the artist as to the values and proportions of his work and that the designs always look better on the soft-colored stone than they do on the glaring white paper. This observation led to printing on paper tinted like the stone, and the results fulfilled expectations. There were difficulties however. The very best quality of this paper is extremely dear, and other qualities had the property of dirtying the stone, on account of the coloring-matter used for tinting them. Therefore the attempt was made to print the design on white paper and to color it afterwards. Here, too, there arose many inconveniences, so that at last there came the thought of laying a yellow tint over the impression by means of a second printing. This method proved to be not only the most economical and quick, but it had the further advantage that the margins of the paper could be left white, thus enhancing the value of the design. Hardly had it been used with success a few times before Herr Piloty conceived the idea of printing the high lights into the design with white printing-color, so that the impressions would resemble actual drawings. My experiments toward that end did not result satisfactorily, because no white oil color will print well enough; and I proposed that the high lights be engraved into the tint plate and thus permit the original white of the paper to show. So there came that kind of crayon impression with one or more tint plates, which has become so popular that various art connoisseurs hold it to be the triumph of the lithographic art.

To make and print these tone plates, I have thought out many ways; but as I am sure that they will suggest themselves to those who have grasped my text-book, I will describe only the best of them all.

Take a stone of good average quality, the best not being essential, and grind it as for crayon work with a grain not too coarse. When it is clean and dry, cover it uniformly with the following chemical ink, which must be laid on so thickly that it surely will resist the aquafortis sufficiently, yet not so very thickly that it will hinder the drawing-in of the lights later on.

The chemical ink for use on the tone plates is made of four parts wax, one part soap, and two parts vermilion. The two first materials are melted in a clean vessel over a moderate fire and then the vermilion is stirred in.

A piece of ink as large as a hazel nut is rubbed down in a clean coffee cup and then dissolved in rain water till it is just fluid enough to lie evenly and nicely on the plate when applied with a soft brush.

When the stone thus has been painted red, it must be permitted to dry thoroughly. When it is dry, a strong impression of the design is made on sized but well-dampened paper with a printing-color rather soft than firm. Before the paper has a chance to dry and thus to shrink, the red stone is placed in the press and the impression is laid on it face down. Use moderate pressure. The drawing will transfer itself to the red surface, but the paper will stick. Wet it with weak aquafortis till it is completely softened and permits itself to be removed. Care must be taken not to spoil the drawing by violent wiping and rubbing.

This method is easier if a special transfer paper is used. Coat well-sized, very clean paper with a thin paste of starch such as laundresses use for stiffening linen. This paper must not be dampened very much, because then it will not take the impression well. It also is removed from the tone plate by washing with weak aquafortis and it yields very easily, because the paste lets go of the color readily.

When the design has been transferred to the tone plate, take good iron instruments and remove the wax surface wherever the high lights are

desired. As the stone is ground rough, the scraping will produce only small specks at first, because the instrument will touch only the relief points. The more the scraping proceeds, the deeper it will go, till at last one reaches the bottom of the coating and thus obtains a white light. Experts can so manipulate the tint plates that the lights will be graduated from the softest to the most glaring.

As soon as the lights are drawn in, the margins of the drawing are scraped the same way. Then the plate is treated to several washings of pretty strong aquafortis, about twenty parts of water to one part of aquafortis. After coating with gum, it is ready for printing.

The most important requisite for this printing is a good arrangement that will insure an exact register of the second impression with the first, that the lights may appear exactly where they belong.

To achieve this, the practice used to be to draw two register marks on the stone holding the original design, which were transferred to the tint plate with the rest of the design. When the first impression was made, the printed paper was cut away exactly at the marked points, and laid accurately, on the tone plate, being guided by the two marks there. This was effective, but it had the fault that the paper had to be trimmed off carefully for each impression and that the slightest inaccuracy spoiled the register. However, it is very useful for printing proofs.

It is far better to have a printing-frame that is so fixed that it will never shift its position in the slightest degree. To this is fastened a little movable frame that has two steel needles whose position is adjustable at will. Lubricate the leather inside with wax and lay a sheet of white paper on it. See that the tint plate is so fastened in the press that it cannot stir out of place. Make an impression and take care especially that the two register marks print off well. Now set the needles in the little frame so that they will be exactly over these two marks. If, then, an impression of the design is laid on so that the two guiding-marks on it come exactly under the two needles, it will, of course, register perfectly. Of course the little frame must be so adjusted that it can be folded back out of the way before each impression, and the printing-frame must hold the sheets of paper so that they cannot move.

To color the tint plate, use a firm varnish tinted with umber, or any other color that will give the desired effect. New rollers are best, insuring a fine, even, unspotted tone.

(3) In rough-grinding the stones, it is difficult to prevent scratches and furrows caused by the coarse sand. No design of value should be made on such a stone, but if one is used, the defects should be touched up with chemical ink and a fine brush, as crayon will hardly do it.

(4) As the delicate places in crayon work are not durable, etching having the property of reducing the light portions and darkening the darker ones, I tried the method of drawing the lighter portions on a separate stone in rather stronger manner and printing from it with paler ink. The success was so great that I hope in time to produce true masterpieces with the aid of skilled artists, and here call attention to it in advance.

(5) After learning how to make a second impression over a first one, it is not difficult to pass on to printing with several stones and from that going on to color-printing. In the early days of my invention I tried color-printing with a crayon plate and had the best success by using stencils such as are used by the painters of cards. On oiled stiff paper I made as many impressions of a design as there were to be colors. Then all that was to be red was cut out from one stencil, green from another, and so forth. Then the stone was wetted, the stencil laid on it and the uncovered parts of the stones inked-in with the right color. After all the colors had been applied, I made the impression, which generally looked neat enough, but still resembled a sketchy drawing rather than a painting, because no color except black, zinc red, and dark blue permitted itself to be printed strongly enough. But by using several stones, each of which can be designed and treated according to the necessities of color, impressions can be made that resemble the English colored copper prints very closely, especially if the crayon and pen or brush methods are united.

(6) A stone plate may be etched so that it will have the roughness needed for crayon work. Grind it as clean and smooth as possible with pumice, pour aquafortis over it and coat with gum. Wash it well in water and dry with a clean cloth. Coat it very thinly but uniformly with tallow into

which is mixed a little lampblack, so that one can see if the coating is perfectly even. With a small ball or roller covered with fine cloth, roll or pat the stone till it has a very uniform tone. Now pour a little diluted aquafortis on one end as a test to see if it penetrates uniformly through the fatty coating. Practice is needed to hit just the right thickness that the tallow coating must be. It must be thin, and yet sufficiently thick to resist the aquafortis somewhat, so that it yields only at those places where the roughness of the cloth on the roller has removed it more or less.

If the test is satisfactory, make a raised border of wax around the stone and pour the aquafortis solution on it. A solution of forty parts of water to one part of aquafortis is better than a stronger one because the stones are more equally attacked. As soon as the resulting bubbles are as large as the head of a small pin, the etching fluid is poured away quickly and replaced with pure water to get rid of the bubbles. Pour away the water and apply etching fluid again. Repeat this four or five times, according to the grain desired, and in the end wash the stone well with oil of turpentine to remove all fattiness. Then it must be washed with weak but very pure aquafortis, followed by a great deal of very pure water. After cleaning and drying very carefully with a clean rag, it is ready for use; and if the work has been well done, a grain will have been produced that is prettier and much more even than can be produced by rubbing with sand.

(7) The instructions given here teach how to draw on a stone that has been prepared beforehand with aquafortis and gum. This is not in the least inimical to the durability of the design if only the union of the gum with the stone has been destroyed again by washing afterward with diluted but pure aquafortis and every trace of this acid again has been removed by copious washing with pure water. If there is a considerable amount of the soap in the crayon, the good result will be greater than with an entirely clean stone, because, since it has already been etched twice, the etching after the design may be very limited, so that it is not harmful to even the most delicate shadings in the design.

(8) Some attempts made by me to etch crayon designs more powerfully than usual proved that the more delicate places would suffer, but if I

rubbed them up with a flat knife as described before, they appeared again and I had the advantage that the whole plate was much better prepared than it is with weak etching.

(9) If a crayon plate is spoiled in printing through carelessness or lack of skill, the rules for remedying the trouble are the same as those named for pen work, and the judgment of the worker must decide which method is the most applicable. In general, it may be assumed that the best remedy for blurred spots is to draw them over again with crayon; and for smutted parts the best is to apply firmer printing-color, or to cleanse with oil of turpentine and gum and afterward ink-in with acid-proof ink, and then use light etching with weak aquafortis followed always by coating with gum and water.

III

TRANSFER AND TRACING

In the pen and crayon method all the lines that are to take printing-color are drawn directly on the stone with a fatty preparation. But lithography has a unique way of transferring to the stone a drawing or inscription that is first put on paper with the fatty substance. This is possible only for lithography, and I incline to the belief that it is the most important of all my inventions. It makes it unnecessary to learn reverse writing. Everybody who can write on paper with ordinary ink can do so with the chemical transfer ink, and this writing can then be transferred to the stone and manifolded indefinitely. In Munich and Petersburg this method has been introduced for government work. The measures adopted in council are written during the session by the secretary, with chemical ink on paper, and sent to the printery. Within an hour impressions are ready to distribute among the members. I am convinced that within ten years every European Government will have a lithographic establishment.

In war the method would have a great value. It would replace the field printery, and it permits greater speed and secrecy. The commander need merely write his orders himself and have them printed in his presence by a man who cannot read, to be sure that his plans will not be betrayed. The

engineer officers can draw plans and have them circulated among the officers who need them.

Authors and scientists will find the method to be the means of circulating their works in manuscript very cheaply.

Even artists will respect the method when its gradual perfection enables them to draw their pictures on paper with ink or crayon and reproduce them.

Not from boastfulness, but from conviction of the importance of the method, have I thus recounted its advantages. I could fill a whole book with detailed explanations. I wish to gain friends for the method, that it may be improved to its ultimate degree by skilled artists.

The chemical ink used for the paper may be soft or firm. The paper may be specially prepared or not. The stone may be warm or cold. The design leaves the paper entirely and clings to the stone, or does so only partly. To describe all this would take too much space. I will describe only the method that I consider best, namely, a method under which the work is done with a soft ink, and transferred to an unwarmed stone. This is the quickest and surest, and has the advantage of not spoiling the original.

In a clean coffee cup rub down a piece, as large as a hazel nut, of the chemical ink described under the heading "Transfer Ink" in an earlier part of this work. Dissolve with rain water or soft river water. The amount of water is determined according to the need for fine or coarse work. In the latter case, the ink should be thinner, that there may not be too much ink in the design after it dries.

While the writing or design is drying, select a stone that either has not been used before or at least has been thoroughly ground off, and grind it down once more with pure and dry pumice stone without water, until it is certain that all parts of the surface have been rubbed down so thoroughly that the stone may properly be considered a new one. Clean away the dust with clean paper, fasten the stone in the press, examine the scraper to make sure that it is even, adjust the press for the proper pressure; in a word, do all that is necessary for good impressions. From this time on the

greatest care must be taken not to touch the polished stone with as much as a finger, not to mention keeping grease and dirt away from it.

As soon as every point in the design on the paper is perfectly dry, wet it on the reverse side with a sponge dipped into weak but pure aquafortis until the paper is quite soft. Lay it between waste paper sheets for a time, to prevent it from pulling out of shape and to remove the excess moisture. It must be soft, but not wet, when the impression is made.

Lay the paper face down on the stone. On it lay two sheets of dry waste paper, then an equally large piece of taffeta, another sheet of waste paper and make the transfer print with a moderately swift motion of the press, which must have more tension than is used for ordinary impressions. The power of a lever press is insufficient for larger stones, and a cylinder press is required.

After a few minutes the stone is withdrawn from the press, the paper is lifted off and the stone permitted to dry for a minute. It is better if one can wait longer. Then put it into the etching-trough, and pour over it, quickly and only once, a clean but weak solution of one hundred parts of water to one part of aquafortis. It is necessary to be skillful enough to cover the whole surface with one application. Then the stone is washed by pouring pure water over it, and, if time permits, set aside to dry. If time is limited, the gum solution to prepare the stone can be put on at once. Now the transfer is on the stone, properly etched and prepared. To make clean impressions, however, the printing-color must first be rubbed on, then the stone must be inked-in with acid-proof color and after that undergo another etching, a trifle stronger.

To rub on the printing-color, rub a little acid-proof color into a piece of clean linen or cotton, so that it is well permeated but not thickly covered. Rub this rag gently to and fro over the transfer while the gum is still on it, till every part of the design is nicely inked. This rubbing-in of color is an important part of many of the processes that will be described later.

Now clean the stone well with water, ink-in with acid-proof ink, and etch it again as has been described several times. Then it is ready for printing. The last etching is not necessary if only a few impressions are desired.

Transfer is applicable not only for pen designs but also for crayon. The crayon used for the purpose should be softened a little with tallow, or, if the harder crayon is used, the stone should be warmed when making the transfer. But it must not be inked-in or have color rubbed on, until it is quite cold again. For crayon transfer the paper used generally is fine drawing-paper. It must be wetted with somewhat stronger aquafortis that it may release the crayon more readily. The rest of the process is the same.

Besides these two methods, the transfer process can be used for all products of the book-printer's art, type as well as wood-cut. A freshly printed sheet can be transferred directly to a stone, especially if the printer has used our before-mentioned acid-proof ink instead of his ordinary printer's ink. To get a perfectly clear transfer it is necessary merely to see that the printer does not use too much overlay, which would stamp the type too deeply into the paper; and that before trying to transfer the printed sheet to the stone it is subjected to gentle pressure in the press to free it from all inequalities. To do this without at the same time risking any loss of ink which might subsequently weaken the transfer, the sheet is well wetted, laid on a clean, wet stone that has been prepared so that it will not have any inclination to take color, and subjected to a very slight pressure, the press being used with almost no tension. This makes the printed sheet beautifully even. Then if it is transferred to a stone properly prepared as described before, the transfer will be perfect.

Even old book pages can be freshened up and transferred. I have spoken already of those that are on unsized paper. With prints on sized paper the method is as follows: —

Make a paint-like mixture of fine chalk and starch paste. Thin it down with water and paint the sheet. Dip a bit of linen rag into a thin color made of thin varnish and tallow tinted with vermilion. Touch-up the wet paper with the rag till every bit of type has taken red color. Pour clean water over it and touch-up the paper everywhere with a ball of fine cloth stuffed with horsehair. This will remove all surplus color. Continue this till the type matter is only faintly red. Then the paper must be washed very thoroughly with many pourings of water and laid between waste

paper sheets to remove all surplus moisture. The transfer and so on must be done then as in the other cases.

Good transfers can be made also from a copper-plate engraving if the copper-plate impression is made with our acid-proof ink. The ordinary copper-plate ink is not so good. It will be self-evident that designs on stone can be transferred and reproduced the same way.

The tracing process has the property in common with the transfer process that it transmits only a small amount of fattiness to the stone and requires subsequent rubbing-in of color to give it strength.

Coat a piece of thin and clean vellum paper with tallow and lampblack and wipe it off again as neatly as possible, so that there remains only a thin film, which will not smut the stone when laid face down, unless pressure is exerted. Now draw on this with a clean English lead pencil that contains no sand, or with a composition of lead, zinc, and bismuth, and the pressure will force the design on the stone and transfer its fat, which then penetrates the stone and will give impressions. In preparing a stone thus made, greater care in etching is necessary than even in the transfer process. Very weak aquafortis solution must be used.

The process is something between pen and crayon work. It is quite applicable for sketches and pictures that are to be illuminated.

IV

CONCERNING THE WOOD-CUT STYLE

For this purpose, the stone is coated completely with chemical ink on the places where this style is to be used. As soon as it is dry, the lights are drawn into it with a steel engraving-needle that is ground to a sharp or broad point according to requirement. Those parts that are to be very white, with fine lines and specks, are best drawn in with the pen. Thus the wood-cut style differs from the ordinary pen design chiefly in character and in the treatment of the darker parts. Its practice is much easier on the stone than on wood, and it can be combined with crayon work. Etching, preparation, and printing are the same as with other styles.

V

TWO KINDS OF TOUCHE DRAWING

One of these resembles the wood-cut style in method but in effect approaches copper-plate work. The stone is grained as for crayon, etched, prepared with gum, cleansed with water, coated well with soap-water, wiped, dried, and finally coated with a thin, colored covering of fat, by either coating with acid-proof ink or with hard chemical ink.

This first etching and preparation are required to prevent the fat to be applied afterward from penetrating too deeply into the stone, so that it may adhere only to the surface.

Now the design is made on it with a steel scraper. The manipulation is like that for making tint plates. It demands greater care, however, and better etching.

The completed design is etched (phosphoric acid being best) and coated with gum. A few drops of oil of turpentine are poured on and all the color is wiped away with a woolen rag, but without any rough rubbing. Then the plate can be inked-in with fairly firm acid-proof ink.

The second method would excel crayon work if it were perfected. I have advanced pretty far with it. It is an imitation of the ordinary wash drawing which is done with a brush and dissolved Chinese ink on paper.

The stone, which must be very clean and free from all fat, is grained, coated with soap-water, cleaned with oil of turpentine, and dried. Then a hard chemical ink, which may contain a little more soap than usual, or the ink described for brush work, is dissolved in pure rain water and used on the stone with a brush just as it would be used on paper.

When the design is finished and very well dried, the entire surface of the stone is rubbed gently with a fine cloth, in order to perforate the color with tiny holes everywhere. As it will perforate more readily in the parts where the ink has been laid on thinly, the succeeding aquafortis will eat through there more easily, and thus the etching will correspond nicely with the tones of the design. It is necessary, however, to know the strength of the acid and the resisting power of the ink very accurately. It is well to

experiment and write down the best proportions. In any case, the etching fluid must not be too strong and the etching must not be done by pouring or brushing, but in the copper etcher's manner, by framing the stone with wax so that the fluid will lie on the stone. As soon as the resulting bubbles reach the magnitude of a pin's head, the fluid is poured off instantly and then poured on again till the bubbles reappear. How long this must be continued depends on the strength of the ink.

It is understood, of course, that the etched stone must then be coated with gum.

VI

THE SPATTER METHOD

This speedy and easily executed style surely will come into wide use soon. It is done as follows:—

The outlines of a design are laid on a stone prepared for pen work, by tracing. Then they are traced again, say four times, on sheets of paper. On each sheet everything that falls into the category of one of the four chief tones is cut out with a sharp penknife so that the four sheets are like the stencils of card painters. Now the chief lines of the design are made on the stone with chemical ink, using either brush or pen. Lay one of the stencils on it exactly, weight it that it may not move, and perform the operation of spattering.

This is done by dipping a small brush, such as a clean toothbrush, into chemical ink and scraping it with a knife so that the ink is spattered over the stone. Care must be exercised not to have too much ink in the brush, for fear of blots or over-large spattering. After practice it will be possible to produce such fine and uniform dots as cannot possibly be produced by the pen. After the desired grade of shading has been achieved, the stone is permitted to dry. Then the second stencil is laid on and the operation repeated till all have been used. If enough stencils are made, the whole design can be made by spattering. It is not necessary, however, to make many, as the design has to be finished up by hand afterward anyway.

This finishing-up is done first with the engraving-needle, which opens

and decreases all dots that are too large, and then with the pen, which brings out the true proportions of the various tones.

VII

TOUCHE WITH SEVERAL PLATES

This really is only a process of using many tint plates. It makes splendid effects possible, equal to any produced by an artist with Chinese ink, and deserves the attention of all artists, especially as it is the easiest and quickest of all methods, even though it is a little circumstantial in the printing.

Draw the outlines of a design on the stone in chemical ink with pen or brush, and then make four, five, or six transfers on stone plates prepared for pen work. Register marks must be on the design. Now draw-in the darkest parts on the first plate, the less dark ones on the second, the lighter ones on the third, and so on till the whole design is finished. The work is best done with a brush. One or more of the stones may be designed with crayon; but the number of stones designed with ink must be greater, in order to make the grain of the crayon designs unnoticeable.

The etching is done as in pen work. For each stone the printing-color is chosen according to the tone of its design. Of course particular accuracy is vital; but the artist should not permit the apparent difficulties to frighten him, as he will see very soon after trial that no other method produces such beautiful results.

VIII

COLOR-PRINTING WITH MANY PLATES

This method, in which the various colors are drawn on several stones, either with pen or crayon, resembles the one just described.

According to treatment the impressions will resemble a painting, a copper-plate engraving in color, or an illuminated copper-plate engraving, if the color stones are used merely to lay colors over a design already printed in its entirety in black.

The whole process is so like the preceding one that I need merely recount the colors that I have found serviceable for the purpose.

RED. Vermilion, red lake of cochineal, fine madder lake, and finally carmine if it is mixed first with Venetian turpentine before being combined with varnish, as otherwise it inclines to separate from the varnish and unite with water, staining the whole printing-paper red.

BLUE. Berlin blue and mineral blue. Use only a small amount, sufficient for a few hours. These colors dry quickly, and, besides, make the varnish too tough, so that they must be thinned down from time to time with a little linseed oil. Fine indigo is very good, also a blue lake that is made of logwood and verdigris. This latter is not durable in sunlight.

I have had no success as yet with green or yellow.

Verdigris is difficult to manipulate because it smuts the stone easily and does not tolerate many mixtures. Schweinfurther green, one of the new colors, is much better in all respects, but not dark enough. Mixtures of yellow lake with indigo or mineral blue are not very durable. Golden yellow ochre with mineral blue or indigo does not produce a pretty green, and King's yellow mixed with blue is handsome but not durable. Neapolitan yellow and the newer chrome yellow with blue produce a green that is not dark enough.

I have obtained the handsomest and darkest green by printing the design blue first and then printing over it a yellow plate, so that the yellow lay over the blue. By using Berlin blue and fine ochre a fairly handsome color is produced. On account of its loss of color in water, ochre cannot be used unless Venetian turpentine is first mixed with the varnish.

A handsome and at the same time dark yellow is equally hard to obtain. Till a good color is invented, we must content ourselves with ochre, Terra de Sienna, Neapolitan yellow, mineral yellow or chrome.

This printing with various colors is a process for which the stone is superior; and it is susceptible of such perfection that in future true paintings will be produced by its means. My experience convinces me of this.

IX

GOLD AND SILVER PRINTING

This process is useful for decoration.

Those parts of the design that are to appear in gold or silver are drawn with chemical ink on a stone prepared for pen work. After the drawing is dry, it is etched and prepared in the usual way. The printing is done with a silver gray color of firm varnish, fine crayon and a very little lampblack. The paper must be entirely dry and very smooth. Soon after the impression has been made, the printed parts are covered with silver or gold leaf such as is used by gilders. It is pressed on slightly with cotton, that it may adhere, and then a sheet of paper is laid over it. Then the second impression is made, treated the same way, and so on.

No more impressions must be made than one can cover with silver or gold in two hours. If the ink is on the paper too long, it will draw in and not take the metal well. After gilding or silvering, the sheets must lie for some hours or till the next day, that the ink may take perfect hold of the paper, so that, in the succeeding pressing, it will not penetrate the metal and make it look sooty. The pressing is done by laying six or eight impressions on a clean stone under the press and passing them through as for printing, with the proper tension. This tension must be adjusted according to the firmness of the printing-color; therefore it is best to make test with one sheet. Then, if the metal does not adhere sufficiently, the pressure can be increased.

In the end all surplus gold or silver is removed by gentle wiping with clean cotton. This is easy, as it will have fastened itself only to the printed parts. If the impressions can be set aside for some days without being wiped, it is better, and there is not so much danger of injuring the brilliancy of the metal.

If gold and silver are to be printed on designs where there is other color also, or where there is black, the print on which the metal is to be applied must always be made first. Only when the sheets have been gilded or silvered, pressed, wiped, and cleaned, is the black design to be printed on

from the next plate. That all this must be done with the register marks previously described is, of course, self-evident.

So I close my description of the Relief method; and I hope that I have made it all so clear that good results will come to all who follow my directions.

CHAPTER II

INTAGLIO METHOD

This differs from the other in that the fat, which is to attract the printing-color, is under the surface of the stone, the design having been either engraved-in or etched, and then filled with fat.

Like the preceding method, it has several branches. The best are these: —

I

THE LINE ENGRAVED STYLE

This is one of the most useful branches of lithography, and if the artist has attained enough skill and the printer knows his trade, it approaches very near to the handsomest copper plates, and at the same time is about three times easier and quicker than work on copper. It is splendidly adapted for writings and charts.

Choose a hard, uniform stone of the best kind. Grind it as finely as possible. Etch with aquafortis and prepare with gum. This, at least, was my early method, and it has remained in use in all printeries. Later, however, I discovered that it is almost better to coat the stone with gum without previous etching, because it can be more easily worked then. Only in that case it must be perfectly clean and contain no concealed fattiness. Immediately after the stone has been coated with gum (not some hours later, as many do) the gum must be removed with water, that it may not penetrate too deeply and thus cause a condition which will prevent the finest lines from taking on color subsequently.

Then coat the plate with a tint made of gum solution and lampblack or

red chalk. Use a soft brush to make the coating very thin and uniform. It has the double purpose, first, of giving the stone a color so that the engraver can see his work, and of covering the prepared surface of the stone with a protective coat that later will admit the fatty printing-color only where it has been pierced by the engraving-tool. It is evident that this latter property is increased according to the amount of gum in it, yet only little gum must be used in it, the permissible amount being only just enough to insure that the coating shall not be easily wiped away during the work of engraving.

The stone must be absolutely dry before any work is done on it. Then the design is traced on it, or drafted directly on it with lead. Transfer by printing from paper is not advisable, because the resulting fattiness of the design makes the graver slip.

For the actual work of engraving there is no counsel to be given except to choose good and sharp needles of the very best steel, hard enough to cut glass; and that all lines must be graved clean. There must be no excessive pressure, and in wide strokes there must be no excessive depths. In making very fine lines the stone should merely be touched by the tool. If they appear white, and a little fine dust is observed, one may be certain that they will appear properly in the printing. Broad lines often can be made with one stroke of a flat needle, but generally they are made by continued, gradual scraping. If the stone is to be only lightly wiped during printing, the broad lines must not be deeper than strictly necessary to make them clear, as otherwise they will squash. In true art works, however, which are to be printed with firm color and under more powerful rubbing and wiping, the depths of all lines must be considered carefully, as they will print darker or lighter according to depth.

Of all things the worker must take heed against touching the stone with dirty or greasy hands, for a plate thus blemished is not only difficult to engrave, but the grease finally may penetrate through the slightly gummed coating and enter the stone, making much consequent trouble when the printing begins.

It is more harmful still to wet the stone in any way, because then the

coating gum will dissolve, penetrate into the engraved lines and give them a preparation, so that they cannot take color afterward. Therefore, especially in winter, a very cold stone must be warmed before working on it with the design, as otherwise the moisture in the room will precipitate itself on the stone. Even the perspiration of the hands or the moisture of the breath may cause damage. Therefore a good but careful warming is very advisable.

If a plate has become moistened, as, for instance, from a breath, it must be permitted to dry before doing any further work on it, and especially it must not be wiped.

The dust resulting from the engraving is to be removed either with a soft brush or by blowing it away.

Faulty lines that are noticed during the engraving may be scraped flat very carefully so that no furrows are made, or they may be rubbed off with fine pumice, after which those places must be prepared again, and coated with gum applied with a small brush. Then the corrections can be made. If only tiny places are faulty, they need merely be coated with a mixture of weak phosphoric acid, gum, and lampblack or red chalk. This prepares them. Thus they will not take color during the print, and so are practically removed.

When the design is finished, the stone must be very dry that it may take color well. But it must not be warmed, as this would incline it to take smut. A color consisting of thin varnish, a little tallow, and lampblack is now rubbed swiftly into all the depressions, and immediately wiped away again with a woolen rag wetted with gum solution. This removes the original red or black coating also.

Thus the hitherto colored stone becomes perfectly white, while the engraved design, which has appeared white, is now black. The first impression that the eye will gain will be that now the design appears much finer than it did before. That is because every white line on a dark background looks wider than a black line of the same thickness on a white background. Therefore, while engraving, the artist should aim to make his lines a trifle bigger than his eye would suggest.

In printing the stone the usual precautions required in every form of lithographic printing must be observed. Beyond that, the matter of chief importance is the proper composition of the printing-color.

Stone plates made in this way can be inked-in (1) by rubbing-in the color and light wiping, and (2) by harder wiping, and (3) by the ink-roller.

For the first method, a color can be made of thin varnish and burned lampblack, the latter being present in fairly large quantity but very finely rubbed-down. Into this color is mixed a quantity, equivalent to one half the mass, of gum solution that is almost as thick as the color itself. Everything must be mixed perfectly. If the solution is too watery, it is not easy to mix it.

Three clean rags of cotton or linen are needed for inking. The first is used to wet the stone and to clean it again in the end. The second is colored with a small quantity of printing-color and rubbed in by thorough wiping to and fro. The third rag is used to clean away any surplus that may adhere. Then the first clean rag is used to cleanse the stone thoroughly.

All three rags must be wetted with gum solution, and the first and third must be washed several times during the day.

The stone plate is harder to clean at first than after some fifty impressions have been made. Often there will remain little specks of color on the prepared places, which are easy enough to wipe away but are inclined to reappear. To remedy this it may be necessary to use more clean rags in the beginning or more gum solution. If the stone has been polished very well in grinding, this trouble will not be very noticeable if at all. Under any circumstances, it will disappear gradually during the printing, so that at last it will be possible to clean the surface with the very same rag that lays the color on and is permeated with ink.

In the second method, the wiping is harder in order to take more color away from the shallower lines, so that they will be pale compared with the deep ones which then will appear very black and strong.

If the full beauty of a well-made copper plate is to be equaled, care must be taken, as said before, to achieve the proper depth of engraving,

and the stone must be wiped harder. Otherwise the method is the same, except that beautiful, shining impressions often can be made by using a firm color, if the stone can bear the necessary tension.

The inking-in with the ink-roller is like the same process in other methods, except that the color must be softer and the roller well filled with it. It is necessary, also, to learn by practice how to work the color into all the deep lines.

The impression must be made immediately after inking, as otherwise the color will sink too deeply into the stone and not give a strong impression without renewed inking.

The paper must be wetted a little more than in the other method.

The tension of the press is according to the size of the plates, but on the whole must be two or three times greater than for the other methods. More pressure still may be needed for very fine work, as the finer lines often are harder to print than the coarse ones.

As soon as the first clean proof is pulled, it must be examined for errors or faults in the design. If there are any, the stone is removed from the press after being delicately coated with gum, and the correction is made as follows: Before anything else, all such faults as are to be removed entirely are either scraped away with a very sharp knife or rubbed away with a very fine stone. The manipulation must be very delicate to avoid grooves and furrows or sharp edges that afterward will hold dirt. Then the parts thus corrected are coated with a mixture of about six parts water, two parts gum, and one part aquafortis to prepare them anew.

If anything new is to be added to the design or drawn in place of an error, the stone is washed with water throughout, or, if the correction is to be made only in a very small part, washed at the desired place. Then it is coated with the red chalk as described in the beginning, but so thinly that the design can be seen plainly through the red coat. Now all that is desired can be engraved, filled again with the rubbing-in color, and turned over to the printer, who cleanses it with gum water and proceeds to print.

Only a few more useful suggestions: —

(1) It happens often that after the first rubbing-in of fat color and the

succeeding cleansing with water, the stone gets a "tone" over its whole surface; that is, it takes color at least partly, and thus seems to have lost its original preparation. This may be due to the fact that not enough gum has been used in the original coating, or that the rubbing-in was rough enough to injure the protective coating, or that the rubbing-in-color was left on too long before being washed away with gum solution.

A similar fault may develop with the second rubbing-in, after corrections, and from the following causes: Poor color containing sand; too much pressure with the greasy rags; the use of rags not sufficiently cleansed of any soap used in washing them; rubbing-in of color with too dry a color rag; in brief, from anything that may destroy the stone's preparation wholly or in part.

Sometimes this defect may be remedied by mixing more gum into the printing-color and into the water with which the cleaning-rags are wetted. A firmer color may aid, if it is rubbed away by fairly strong pressure of the rag as soon as it has adhered. This operates as a remedy because the firm color takes hold of the dirt that has set itself into the pores of the stones, and when it is removed, takes the dirt with it. If none of these have results, there is nothing left except to grind off the plate very slightly and carefully with an exceedingly fine stone and gum solution. In the case of very delicate designs, this is not applicable, because the finest lines have practically no depth. Therefore they must be washed instead, a rag being dipped into weak aquafortis or very much diluted phosphoric acid, and passed carefully over the stone till the dirt disappears. It is well to mix in a little gum, and also to rub acid-proof ink into the stone first, that the etching fluid may not attack the design too much.

After this cleansing the tone will disappear, but another fault often appears in place of it. The color, after rubbing-in, will not permit itself to be wiped away readily, because the etching has caused some roughnesses to which the color adheres in the form of little specks. A number of clean rags with gum solution must then be used, or the stone should be lightly rolled a few times with the ink-roller after being rubbed-in. The roller will take the specks. Indeed, the fault hardly ever appears if the inking-in

is done with the roller, as suggested in the remarks about the third form of inking-in.

As soon as some few impressions have been made, the roughness of the plate disappears gradually and it can be wiped off without leaving specks behind. Gentle rubbing with pumice finely powdered and mixed with gum solution will remove the defect in the very beginning, but care is needed lest the design be injured.

(2) A line that has so little depth that it is almost level with the surface of the stone can be made as black as a deeply engraved one by continued rubbing with the color rag. In using a firmer color the lines, especially the wider ones, can be so overloaded after a while that the ink will squash under the press. This surplus can be removed again by the use of the ink-roller, but it is merely adding unnecessary work, as proper practice in inking-in and the use of exactly the right consistency of color will prevent the trouble.

(3) The best way to ink-in an intaglio design is to rub it in at first with a somewhat firm color that however, contains enough gum, then to wipe it a bit, and after that to rub gently to and fro over the stone under gentle pressure, with a rag containing a less heavy color. A firmer color does not adhere well to the more delicate lines, or, at least, is hard to print; but by applying it first, the printing of the wider and deeper lines is facilitated, while the succeeding rubbing with softer color brings out the perfection of the finer lines.

The second rag with the lighter color must not be filled with it in mass, but should merely be made sooty with it, so to speak. Otherwise the lighter color would penetrate the deeper lines also and mix there with the heavier color.

In the end the stone must be wiped again with an entirely clean rag, as will be understood, of course, and thoroughly cleansed of all the color.

II

THE ETCHED METHOD

In this the design is not engraved into the stone by pressure of the hand, but with aquafortis or other acid, and only so much pressure is exerted in making the design as is required to cut through the thin coating of varnish with which the stone is covered. Therefore this method permits great freedom of action and is applicable especially for landscape work and for drawings in Rembrandt's style. In treatment as in effect it resembles copper plate, and has its own advantage in that the lines may be strengthened gradually by stronger pressure on the engraving-needle. They may even be engraved a little into the stone so that afterward the lines will become stronger under etching. This cannot be done with copper at all or only with great difficulty.

These considerations and the quicker printing permitted by it recommend the method to artists. In other respects it is not different from working on copper. But it is necessary that a good lithographer should be a master of this form of stone work, as it may be used for excellent work, not only by itself but in combination with the other methods.

The stone must be ground as smoothly as possible, then treated with aquafortis and coated with gum, so that its surface thus is completely prepared. The aquafortis may be as strong as that used for etching pen work. It suffices, also, to wipe the plate merely with a sponge dipped in stronger aquafortis, the chief point being that no roughnesses shall be caused by uneven etching.

A few minutes after this first operation is finished, the stone is rinsed with water, dried and coated with etching-ground. This can be best done as follows:—

(1) Warm the stone till an ordinary copper etcher's etching-ground will become so fluid on it that it can be worked with a leather ball like a varnish, and can be spread very thin and very evenly. Great care must be exercised lest uneven warming crack the stone. If one can put it into a nearby

baker's oven, it will obviate the necessity for an especial apparatus, which otherwise is demanded.

After coating the stone with the etching-ground, it is reversed while still warm, and blackened by applying the flame of a tallow or wax candle, as the copper-plate etchers do with their plates. Then the stone is set aside to cool, with great precautions against dust. After it is cool, dust will not harm it, and it can be kept indefinitely before use, so long as the coating is protected against injury.

(2) The method given is the best; but if the warming of the stone is difficult, there is a method applicable to cold stones. The etching-ground is dissolved in oil of turpentine and laid on the stone with a clean ball. A stone so treated must be put away for at least a day in a place safe from dust that the oil of turpentine may evaporate.

To tint this etching-ground, it may be blackened by smoking with a candle, as in the first case; or color, such as lampblack or vermilion, may be mixed-in before it is applied. If one wishes to be very certain that the stone will bear the etching well, it may be coated, very thinly indeed, with a solution of very firm chemical ink after applying the etching-ground.

The design is traced through this coating to the stone. It may be transferred, also, but in that case, as soon as the transfer is on the stone, it must be coated thinly once more with a solution of chemical ink that does not, however, contain any lampblack or other coloring-matter, but is transparent. This is necessary to fill out any little holes and other injuries that may have been caused by the pressure during transfer or by the inequalities in the transfer paper.

The designing with the needle is done as in the engraved manner, except that the design is merely cut into the coating.

When the design is complete, the stone is laid into the etching-trough and diluted aquafortis, muriatic acid, or strong wine vinegar is poured over it repeatedly, according to the depth that the lines are to have.

If it is desired to etch so as to produce various tones, — some strong and some delicate, — after the manner of the copper-plate etchers, the pouring

of acid should cease as soon as the very finest lines of the design have been etched sufficiently. Wash away every bit of acid with clean water and let it dry. Then, with a small brush and chemical ink, coat all parts that are not to be etched further. It is well if the chemical ink used for this purpose contains a little more soap than usual, so that it can penetrate well into all the depressions and leave no little holes. The coating must be done very cautiously, and it is better to paint on too much ink rather than too little, as the design will appear very dirty if etching fluid should penetrate here or there through the coated portions.

When the ink is dry, etching is resumed till the second tones have been etched as far as desired. Then the procedure is repeated, these second tones being coated. Thus one continues till all gradations of shading have been reached.

When the stone is fully etched, clean water is poured over it, and then all the parts that have not been coated with chemical ink are treated to a covering. The object of the previous coatings was to prevent access of acid to the parts; but at the same time the ink prepared the parts. Therefore the remaining portions of the design also must be sated with ink before the stone is inked-in for printing.

Let the stone dry and then pour on it as much oil of turpentine as may be necessary to dissolve this whole ground coating, which then is wiped off with a woolen rag wet with gum solution. Then the stone may be inked-in and printed.

If an error is observed before etching begins, the first question is if the defect is deeply engraved in the stone or if it has been drawn merely through the ground coating without affecting the stone itself materially. In the latter case it is necessary merely to cover the defective place with chemical ink and draw into it the correction. If the error has been graved deeply into the stone, it must be covered for the time being, but nothing new can be drawn there. To do this, one must wait till the plate has been etched and rubbed-in with color. Then the incorrect part is scraped or ground off as evenly as possible, the place prepared anew with aquafortis and gum, and the correction made with the steel needle.

An intaglio design often is greatly beautified by being printed with a tint plate like a crayon design. It can be done with a second stone, but it can be obtained also with the one plate that has the design on it. Wash the designed stone with clean water and then paint a thick coat of chemical ink containing more soap than usual over the whole stone or over only such parts as one desires to improve by adding a tone. If lights are to be worked into this tone, it can be done, after inking-in, with a small brush dipped into weak aquafortis.

In printing a stone thus toned, it must be rubbed-in thoroughly with the black color and then cleaned as well as possible. The tint that shows on the surface then is usually too dark, and the firmer the color the darker it is. Then a second rag must be used with a much softer color, which may even be thinned-down with plain oil or butter. It may also contain another coloring substance. Rub this rag very gently to and fro without much pressure till it is apparent that the dark tone has been replaced by a light one. Then the stone is ready for printing.

Stones to be treated to a tint in this manner must be etched somewhat deeper than others, because the lines do not appear so dark against a tone.

In all intaglio methods there is the advantage that parts that turn out too dark can be modified by fine scraping or grinding. The stone merely must be rubbed with acid-proof ink beforehand, that the necessary preparation of the corrected places with aquafortis or phosphoric acid and gum may not attack the rest of the design. Those who attain skill in scraping or grinding with a small piece of black slate can make the softest gradations of shade in uniformly etched designs, and more easily and quickly than by drawing or coating and etching. If the stone has been rubbed-in with color for the first time only a short time previously, the ground or scraped surfaces do not even need to be etched. It is sufficient to wash them with a rag wetted in gum solution, because the color will not have penetrated the stone so deeply that it is likely to reappear.

III

DESIGN WITH PREPARING INK, COMBINED WITH SPATTERED AQUATINT

If a little dissolved gum is painted on a clean stone that then is inked over its whole surface with printing-ink, none will adhere where the gum is. In other words, the stone will have been prepared there. If the gum is permitted to dry before the ink is applied, those parts will become black, too; but as soon as a few drops of water are poured on and the ink-roller passes over the stone, all the gummed parts will show up white at once. This led me to make a color mixed with gum, with which one can design on stone and that would have the property of preparing it so that, on printing, the design or inscription will print white.

Some drops of gum arabic dissolved in water are mixed with an equal amount of lampblack and rubbed very fine. This makes an ink similar to Chinese ink, and keeps well when dried. It is rubbed down in a saucer with a little water and then is ready for use.

It can be used on a clean stone, but is likely to flow, for which reason the stone must be painted with a little weak aquafortis mixed with a little nutgall, and then well cleaned again. Still better is it to paint a clean stone some days before with oil of turpentine which is cleaned off again immediately. In that case, however, it is well to mix a little phosphoric acid into the drawing-ink, that the designed parts will be prepared the more surely.

When the design is dry, the whole stone is inked with printing-color, care being taken that not a drop of water touches it before it is perfectly black. Then a little water is poured on, after which there must be a little more rolling with the ink-roller till all the design that is drawn with the preparing-ink is very white and clean. Now the stone can be used for printing, being used in the manner used for pen work. To make the design more durable, that it may not in time thicken in its finer parts, the stone may be well inked-in with acid-proof ink and after a few hours, during which it draws together well, the drawing is etched in intaglio with aquafortis. Then it is coated with gum and the printing is not likely to damage the design.

Here we have an intaglio design which is prepared and prints white.

The case may be reversed, and the black plate may be made white again while the design will print black. This is because a stone treated with preparing-ink gives almost the same result, once it is grounded with acid-proof ink and etched as if the design had been engraved into etching-ground. The etched lines need simply be filled with chemical ink as in engraved work, to make them take color instead of coating them with gum. Then there remains only the obstacle that the stone is not prepared over its whole surface and takes color everywhere. However, it is not difficult to clean the plate and prepare it perfectly, especially if the stone is finely polished. It must be rubbed well with color, and wiped clean at once without rubbing too much of it away from the etched design. To make the color easier to wipe out, Frankfurter black and tallow may be mixed in it. Then the rag that has been used for inking-in is dipped into a mixture of twenty parts water, two parts gum, and one part aquafortis, or better still, phosphoric acid, and rubbed back and forth. The rag must not be too dirty and heavy with color, but it must contain some so that the delicate parts of the design shall not be wiped out and thus rendered susceptible to the acid. The next thing is to try with the finger to see whether the color on top can be easily rubbed away or not. In the latter case the wiping must be repeated till the cleansing mixture has so far prepared the surface that the wet hand or a wet piece of leather can cleanse it perfectly and free it from the dark tone. Now the stone is inked-in with firmer color (acid-proof ink is best). This is wiped off again thoroughly. Very weak aquafortis (or phosphoric acid if it has been used for the work) is then poured over it a few times, and this generally prepares it so well that it can be inked and cleaned easily during the printing.

This method is useful for many kinds of art, and it must not be imagined that it is superfluous because the other ways are quicker.

The engraving-needle is very good for drawing the finer parts of the design through the etching-ground, but the coarser ones cause much trouble, while with the pen, these are the very ones that are easiest to produce. By using this method, both advantages can be combined and only that is drawn with the pen which is most readily produced that way.

Thus the whole design, with the exception of the finest parts, is drawn on the white plate with the black preparing ink touche. Then, when it has been covered with acid-proof ink and made white, the finer parts are worked-in with the needle. Or they may be left till the end, when they are engraved-in.

For grounding or blackening the plate, one may use a substitute for the acid-proof ink if the ground is to be firmer. Use the etching-ground (mentioned several times before) of wax, mastic, pitch, and resin, dissolved in oil of turpentine and mixed with fine lampblack. It will then be susceptible of being laid beautifully uniform on the stone with the ink-roller like printing-ink.

The spattered aquatint method resembles this.

The outlines of the design are engraved or etched into the stone very delicately. After rubbing-in with black printing-ink and cleaning again thoroughly, it is rinsed with a great deal of clean water to take away every trace of gum. When it is dry a small brush is dipped into the preparing-ink, and the stone is spattered as described in the article on spatter-work. After drying, the dots that are too large are treated with the needle, and missing ones are drawn in with the pen. Now apply the roller with the dissolved etching-ground, that must, however, have only enough color so that the outlines of the design can show through it. Then the spattered work is brought out by rolling with water. Now coat the lighter parts of the design and etch. Coat again and etch again, in short do as already described for the method of successive etching till the required gradations of shade have been attained. Then proceed as usual with the inking-in and printing.

IV

AQUATINT IN COPPER-PLATE STYLES AND WITH ETCHING-GROUND

Any one who has the necessary appliances of the copper-plate worker for making the aquatint ground used by them, and who has the necessary skill, can do so, although the stone is endangered by the heat, and the process is not advisable. The stone is dusted with fine resin. A flame of

spirits is applied below until the stone is so hot that the resin melts and forms the ground.

Better is that copper-plate method in which the resin is dissolved in highly rectified spirits of wine and poured quickly over the whole stone. By breathing on this, the resin is made to separate from the spirits and form tiny pellets, which thus make the required aquatint ground.

Both methods are better for very coarse work than for fine designs. Etching-ground, dissolved in oil of turpentine, or consisting simply of tallow and put on the stone very uniformly with a cotton ball, is much better, and produces an effect similar to wash drawing. However, it is better suited to the lighter parts of a design, because it will bear long and powerful etching only if one hits exactly the proper proportions between ground and etching fluid. Therefore, it is well, after the first tones have been etched and printed, to spatter cautiously with chemical ink all those parts that are to be darker than half-tones. Thus these dots will prepare the design so well at those places that they can withstand the most powerful etching.

V

AQUATINT THROUGH CRAYON GROUND

This is a sort of middle process between aquatint and the scraped style. It has the advantage of great speediness.

A stone that has been grained for crayon work is coated with the black or red gum ground described for the engraved method, but without previous etching, which would not do harm but is unnecessary. The outlines are drawn in with the needle very lightly, because they are to serve only to make the design visible. Those lines, however, that are not to disappear in the aquatint tone, but are to show plainly, must be cut as deeply as necessary for greater or lesser blackness. Then the stone is rubbed with color and washed with water as in the engraved method.

When it is entirely clean and dry, all the design will be black and the stone white. The design must be examined carefully, and the various gradations of shading should be separated in the mind into about eight lead-

ing classes, of which four are numbered upwards to the lightest parts, and four numbered downwards to the darkest. Everything in the category of the four dark parts now is worked strongly with chemical crayon. The purpose is to mass a number of evenly separated points over these parts of the design that shall withstand the etching fluid like an aquatint ground, between which the etching fluid may eat the stone and thus form a coarser grain than could be attained merely by rough grinding.

Then the four lighter parts must be coated with chemical ink. The very lightest parts, and all that is to remain white, must be left white on the plate and neither touched with crayon or ink.

Then the stone is etched for the first time. Following this pour clean water over it and let it dry. Then of the four dark parts the lightest are coated with chemical ink, and when it is dry the etching fluid is applied again. After washing and drying, the next lighter portions of the dark sections are coated, and so on till at last the very darkest shadows have been coated. Then a clean brush is dipped into gum solution and everything that should remain white is painted.

If a little oil of turpentine is now poured on the stone, and the crayon and chemical ink are dissolved and wiped off, the stone can be inked with soft inking-color and wiped again with a woolen rag. Then the design will look as if a black veil were over it, because the lightest parts of it and the half-shadows are not worked out at all. Wet a rag with gum solution and a little phosphoric acid, and hold it in one hand while with a fine scraper you scrape in the lights according to their gradation or grind them in with a fine stone, for instance, a slate pencil. As you scrape wipe over the design with the wet rag; and you will see exactly what you are doing as the various gradations will appear bit by bit. The printing in this as in other aquatint methods is done with soft and thin printing-color, and the paper may be more dampened than in other forms of lithography. The press needs considerable tension and the stones must be thick.

VI

INTAGLIO CRAYON AND TRACED DESIGNS

The difficulty of getting impressions from crayon that shall not differ from the original design on the stone led me to consider the use of the grained style of the copper-plate engravers. A crayon-like design in intaglio would have a greater strength in the dark parts and greater delicacy in the lighter; be more durable and more easily corrected. I saw at once that if I could attain some perfection, it would mean a great step forward in color printing, also. Thus there were originated the following two processes, which no doubt will in time interest artists to a high degree.

A stone grained for crayon work is prepared with aquafortis and gum. Then it is cleansed with water and covered with etching-ground when dry, as is prescribed for the etched process. The ground must be laid on so thinly and evenly that the design can be put in easily and that it still will resist the etching.

When the stone is cold and the outlines of the design have been traced on it, a scraper of the best steel is used to scrape in the lights and shadows. The scraper touches only the most elevated points of the grained surface at first, and produces larger points only after continued work, just as chemical crayon does. When the whole stone is finished, it is etched as in the etched process and then cleansed and printed in the same way.

If the stone is etched a little more strongly in all its gradations, it can afterward be ground down gently with very soft pumice, or, better still, with black slate and a gum solution, once it has been rubbed-in with color. This destroys all roughnesses that may remain from the first manipulations. Parts that have turned out too dark can be lightened by this polishing, and the over-light ones can be improved with the needle.

The designs made in this manner possess more delicacy as well as more strength than the ordinary crayon designs, and there remains to be desired only that they might have the advantage of the latter of being worked black on white, as it is so much easier for the artist to judge his work on the stone.

Of trials made in this direction, the two following ones met my views the best.

One way is to grind the stone rough, pour diluted aquafortis and nutgall over it, clean it with water and dry it. Then the design is drawn on it with a black chalk made of oil of vitriol, tartar, and lampblack. The further treatment is the same as that in the case of designs done with preparing-ink.

I have not been able to give enough time to this process to invent a preparing-crayon that shall be very hard without losing its preparing-property. However, the compound mentioned will produce a crayon with which one can work well after a few days. It has the advantage that it may be rubbed on a shading-stump made of rolled paper, which will prove excellent for working the finest shadings into the plate.

The other way is as follows: A colorless chemical ink is made of one part wax, two parts tallow, and one part soap. This I dissolved in water and with it I coated the stone, which had been ground rough and prepared with phosphoric acid, nutgall, and gum, and then washed with water. The coating was applied very lightly, but enough so that it could bear the succeeding etching.

As soon as it was dry, I drew the design on it with a black crayon made of tartar, gum, a little sugar, and a good amount of lampblack, or I used the ordinary black Paris crayon or a fine English lead pencil. Then the design was etched, after which alum water was poured over it, and it was set aside to dry.

As soon as it was absolutely dry, I coated it with fatty color, and then cleaned the stone with oil of turpentine and gum solution. If I wanted an exceedingly smooth surface, I ground the stone gently; but then the design had to be etched deeply.

The good results of these two experiments led me to the following process: By following my instructions exactly the worker can produce striking imitations of wash as well as crayon drawings, and at the same time unite the greatest possible ease of drawing as well as certainty of good impressions, so that this process really deserves to be called one of the very best of all printing-methods.

The outlines of the drawing must be drawn on the finest and thinnest paper that can be obtained. Then a very finely polished stone is prepared with aquafortis and gum, or, better still, with phosphoric acid, nut-gall, and gum, cleansed with water and dried. Then it is coated very thinly with tallow, which is patted with a very clean leather ball or with the hand, so that it shall be very uniformly laid over the stone. Everything depends on the thinness and uniformity of this tallow coating. Then the stone must be smoked with a wax torch or a tallow candle. The durability of the ground depends on this smoking, as without it a very thin coating of tallow would be penetrated by the acid.

Now the stone is ready for the design. It must not be touched by so much as a finger. The designed paper is pasted to the stone at the ends, without pulling, as the least motion would injure the stone's surface. The arrangement of elevated supports for the hand (previously described) is needed for the succeeding work. The drawing is then done on the paper with Paris chalk, delicate Spanish chalk, an English lead pencil, or with a small piece of lead. All that is drawn on the paper will impress itself on the stone underneath and remove the ground at those places, thus opening the surface for etching.

When the drawing is finished, it is etched and covered as with the etched process, and afterward is printed as in that process.

When sufficient practice has made one a master of this style, it will be amazing what great perfection, what miniature-like delicacy, and also what strength can be obtained by proper etching.

Besides, this latter process is applicable in combination with the etched process.

VII

TOUCHE DRAWING WITH ETCHING INK

This method is very useful for filling-out etched or engraved designs, also for correcting and completing the various aquatint processes.

Dip a little brush into lemon juice mixed with a little lampblack and draw the design on the finely polished and prepared stone. The acid will

eat little holes into it, which will take color if the lemon juice is washed away as soon as it has completed its etching, and the etched part has been dried and rubbed-in with fat color. To produce darker shadings it can be laid on the same place twice, and for lighter shadings the acid either is washed away sooner or diluted with water.

I do not doubt that a skillful chemist could invent an etching ink which would be even more perfect, and then a drawing could be washed on the stone as easily as on paper, which would mean immense advance for the art.

CHAPTER III

MIXED METHODS

STONE-PRINTING has the unique property, owned by no other process, that it is possible to print relief and intaglio simultaneously. This property makes possible so many combinations of the two processes that a book might be filled with their description. I assume, however, that the reader will have understood the entire science of the new art from what I have said, and that his own reflection will tell him what methods to use or to combine for each of his purposes. I limit myself, therefore, to a few leading methods, thus giving some fundamental idea of the manipulations.

I

PEN DESIGN COMBINED WITH ENGRAVING

This can be utilized in two ways: —

When the pen drawing is finished and etched, the stone may be coated with red gum covering and the needle used to draw-in the finest lines. The printing is the same as with pen work. The second way is to make the engraved or etched part of the design first, and after the stone has been rubbed-in with acid-proof ink, cleansed and dried, to draw-in the rest with the pen and chemical ink. As soon as the design is properly dried, it is etched a little and prepared, and otherwise handled like an ordinary pen drawing.

Both ways carry the advantage that the pen can be used for those parts best done with the pen, and the engraving-tool for those parts best done with it. The latter is especially excellent for very fine and elegant script, such as title-pages, the finest strokes being made first with the needle and the broader ones with the pen.

II

INTAGLIO DESIGN WITH RELIEF TINT

This has been described thoroughly in our chapter on etched work.

III

INTAGLIO AND RELIEF WITH SEVERAL PLATES

As already shown, intaglio and relief can be printed on one stone. Therefore it is evident that the two methods can be utilized still better for several plates, for instance, printing on an etched design with one or more plates that are tinted in relief, or by printing over a crayon or pen design in relief a tone plate in aquatint in intaglio.

How to do this has been explained in the descriptions of relief and intaglio methods.

IV

TRANSFORMING RELIEF INTO INTAGLIO AND VICE VERSA

This is, so to speak, the test of a good lithographer, as it is the most difficult of all methods, and demands exact knowledge of all manipulations. I will try to explain it with a few examples.

EXAMPLE I

To etch a transfer into intaglio

Prepare a finely ground plate with phosphoric acid and gum, wash very well with water, and let it dry. Now transfer to it a design made with soft ink or crayon, or a fresh copper-plate impression. Let the stone rest for a few hours, that the fatty colors may take hold well. Coat it with clean gum

water, and with a rag dipped into acid-proof ink try to rub about as much color on the design as appears to be required to make it withstand some etching. This etching is done with pure aquafortis which in addition has a little alum mixed with it. Etch only enough to eat away the uppermost parts of the prepared surface that have not been permeated with fat. Pour clean water over the whole stone and coat it with strong soap-water that is permitted to dry on it. Finally, clean away the soap with oil of turpentine. Ink-in with acid-proof color which will color the whole stone. Now as soon as it is wiped gently with a rag dipped in gum solution and weak phosphoric acid, the whole design will appear in white as if it had been made with preparing-ink. If the stone is inked now with acid-proof ink and treated exactly as instructed in the article on the use of preparing-ink, the design that was in relief originally will be found in intaglio.

This process is capable of great perfection and can produce true masterpieces especially if the stone is treated finally with the engraving tool.

EXAMPLE II

To etch into intaglio a design made with chemical fatty ink or crayon

Etch and prepare the clean stone with phosphoric acid and gum. Then put on the design with ink or crayon, and perform the succeeding etching and other manipulations exactly as in the preceding case.

EXAMPLE III

To etch into intaglio any design etched into relief

In the two examples given, the plate is etched with phosphoric acid before transfers or designs are made on it. As the weak etching with aquafortis and alum does not penetrate the places where there is fat, these retain their phosphorus-preparation, and thus are not so readily destroyed by the succeeding application of soap, whereas the etched parts immediately drink in the fat as soon as the soap touches them.

In stones designed in the ordinary way, where the design does not lie on the prepared surface, but has really penetrated well into the stone, the transforming is somewhat more difficult, but can always be done after practice by using the following means: —

Wash the stone with water and then coat chemical ink or strong soap-water over it and let it dry. Then clean the stone with oil of turpentine and ink-in well with acid-proof color. Dip a linen rag into gum water and phosphoric acid and endeavor to wipe away the color from the relief design. After wiping to and fro quickly a few times, try with the finger if the design will not whiten, or if the wiping with the acid must be continued. Care must be taken not to injure the ground through too much pressure. When the design gets pretty white, ink the stone with firm acid-proof ink, and then treat as in the preceding cases.

In this way designs in relief that have not turned out as desired can be changed into intaglio, and then, by the use of successive coatings and etchings, as described before, improved by making gradations of tones. But it requires great skill, lacking which one may destroy his plates utterly.

EXAMPLE IV

To change an intaglio design into relief for easier printing

Many kinds of scripts and designs are easier to engrave with a needle than to do in relief with a pen; or one may have workmen who can use the engraving tool better than the pen, as the use of the latter requires more industry and skill than the use of the etching- or engraving-needle.

If one wishes to transform such a design into one in relief, because then it can be printed more quickly and easily and also will give more impressions, the following method will prove useful: —

Ink the stone with good acid-proof ink, and after a few hours etch it like a pen design till it is apparent that the design is showing up. Let it rest again a few hours after etching and become quite dry. Then coat with gum. Otherwise treat it for printing like an ordinary pen design.

Now I believe that I have described faithfully and as clearly as I can all the lithographic methods to which unceasing research and endless experimentation have led me. In the following Appendix I merely make a few useful remarks, which do not pertain exclusively to lithography, yet are intimately connected with it and surely will not be unwelcome to art lovers.

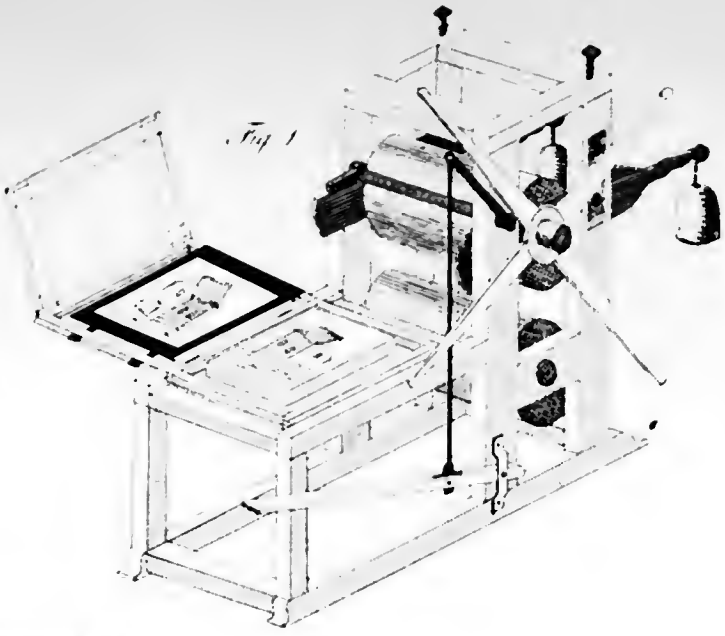
Fig 1

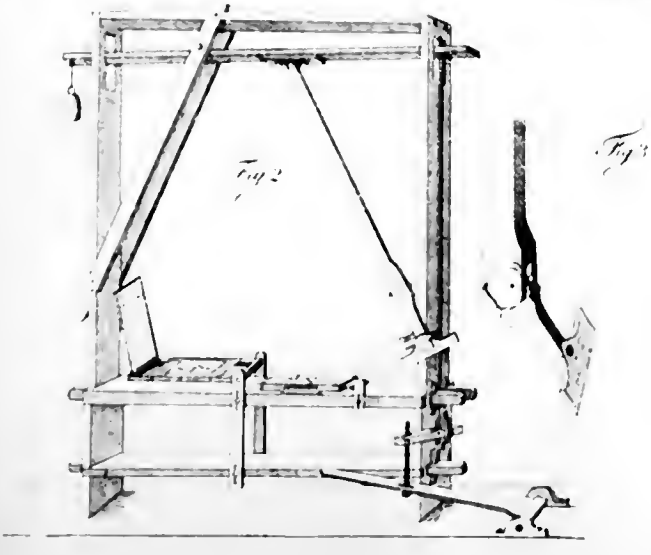
Fig 2
Fig 3

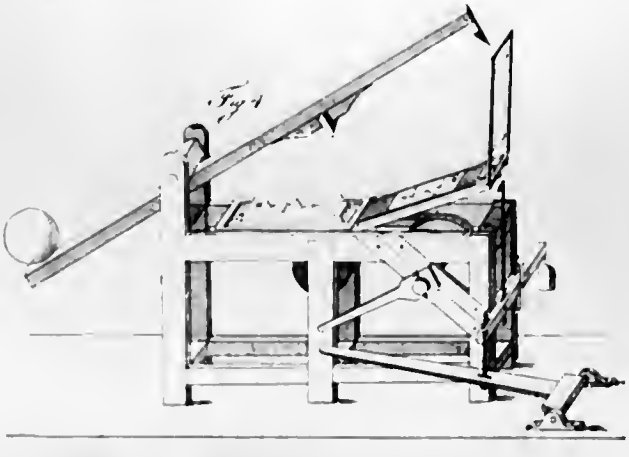
Fig 4

APPENDIX

I

PRINTING WITH WATER AND OIL COLORS SIMULTANEOUSLY

When a plate, whether intaglio or relief, has been inked-in with oil color, it may be coated with one water color, or it may be illuminated with several, and then printed-off in one impression. Two parts of gum and one part of sugar are used for this. They can be dissolved with any water color. Care need be taken merely that the colors are well dried before the impression is made.

If, however, it is desired that the colors have shades so that the impressions may resemble English or French colored copper-plate prints, the process is as follows: —

Etch all shades of the color pretty deeply in any of the stippled or aquatint styles. After this, coat the stone with gum solution, that it shall take no color in these depressions. Clean off the chemical ink or the ground with oil of turpentine, and prepare the whole plate if it has not been prepared already on its surface. Then coat it with red gum surface, and into this inscribe all those lines that are to remain black. Then the color is rubbed-in and the stone cleansed so that it will be white everywhere except in the engraved parts. When it is inked-in now, it can take color there only, and the other depressions (namely the various shades of the color) will remain white because they have been prepared. Now it is necessary only to coat each part with the desired water color and it will be denser, and therefore darker, wherever there are more and greater depressions.

II

SIMULTANEOUS CHEMICAL AND MECHANICAL PRINTING

When a pen drawing is so constituted that the various lines are close together and there is no white space on it that is greater than at most one half inch in diameter, it will permit printing in a purely mechanical way

without being prepared. It need merely be etched into all the relief possible without under-eating the lines. All that is needed then is a color-board or a so-called dauber, made as follows: —

A thin board of soft wood, about eight inches long and six inches wide, is planed down till it is not more than one line in thickness. Glue on it a piece of fine cloth or felt almost as large as it. Over this glue another board, of the same area as the first, but one quarter inch thick. It must be very well-dried wood, and must be made very true with the plane, or better still, by rubbing on a perfectly level stone with sand. This latter board is provided with a handle; and when all is dry this dauber is ground off true again with fine sand and oil on a stone.

Lay the printing-color on this utensil very gently and uniformly with a leather ball. Tap and pat the stone, which has first been cleaned with oil of turpentine over its whole surface, very carefully with the appliance, holding it as horizontal as possible and taking great pains to distribute the color evenly.

As compared with chemical printing, this process in itself has no advantages, but can be united with it and thus used to print three colors from one plate. This is shown by the following

EXAMPLE

Suppose that a design shall be colored black, blue, and red, and that all these colors shall be put simultaneously on one plate. Take a stone made ready for pen work, and prepare it first of all with phosphoric acid, nut-gall, and gum, then wash it with water, and let it dry. Now draw-in all that is to be red with chemical ink, that must, however, contain only just enough soap to permit its solution. When this drawing is dry, etch it into pretty high relief, the higher the better. After this prepare the stone with gum, wash it, and let it dry again. Then coat it with etching-ground that has been dissolved in oil of turpentine, and draw-in all that is to be black, between and over the high etched parts. Then etch this design pretty powerfully into intaglio, after which wash with water, rinse with alum solution, and dry. When the plate is thoroughly dry, rub-in printing-color,

and clean with a woolen rag dipped into gum solution and oil of turpentine. Then it will become white everywhere except in the deep lines where it will have taken color. After cleansing again with water and drying, draw-in all parts that are to be blue, using a chemical ink that contains a great deal of soap. Let this dry well, and cleanse the plate with gum and oil of turpentine again. Then it is ready for inking-in.

To lay on the color, proceed as follows: —

First the black is rubbed-in, as prescribed in the article on the intaglio style. In the very deep parts the stone will get very black. In the parts last drawn, that are level with the surface, it will be only gray, if the color permits ready wiping, which can be facilitated by the use of gum and a woolen rag. Then the tone remaining on the level parts drawn with the chemical ink will be so pale that it will not affect the blue color. Now wipe a rag dipped in blue color gently to and fro till everything that is to be blue has taken the color well. Then take the dauber which has been filled with red color, and pat the stone, which should be dry by that time. Then the parts of the design in high relief will take the red color, and thus an impression can be made with the three colors at once. Each inking-in must be done the same way.

III

USE OF THE STONE FOR COTTON-PRINTING THROUGH WIPING. A UNIQUE PRINTING PROCESS

Etched copper plates have been used for some considerable time for cotton-printing, and as the ordinary oil colors were not suitable for this, while the suitable colors were too fluid, so that they were always wiped out of the engravings, another method was devised. The plate was covered with color and then a kind of straight edge was scraped across it, which removed all color from the surface, leaving it only in the depressions.

This same sort of wiping is applicable to stone, and it is necessary merely to see that the stone is very even and highly polished. The color must be one that permits itself to be wiped off clean, and the wiper must be very uniform and sharp.

Starch-paste or gum with some caustic material is easily scraped off.

IV

COLOR PRINT WITH WIPING

This process is also useful for printing papers such as cotton papers, tapestry, etc. Almost all intaglio designs permit good printing in this way, if a handsome color is used.

Fresh cheese, or drops of congealed milk, mixed with soap, potash, linseed oil varnish, and the desired tint, make an excellent composition, with which all intaglio designs, even aquatints, can be printed handsomely if the plate is very smooth.

If the design is made well, the various colors can be laid on quite roughly, care being taken merely that each color shall be laid only where it is desired. Then the stone should be permitted to dry, after which all the surplus colors can be scraped away with one manipulation, without danger that one will mix with the other in the design.

V

OIL-PAINTING PRINT THROUGH TRANSFER

Colored impressions resembling oil paintings can be made by printing with colors and several plates on paper grounded with oil color. But perfect oil paintings are produced only as follows: —

Make a considerable quantity of special paper by coating unsized paper thinly with starch-paste or glue. On this make the separate impressions from each color plate. If the painting itself is to be produced from these separate parts, take a canvas that has been prepared for oil painting and lay on it a wetted impression of one of the colors, let us say, red. Print this off under light tension of the press, and when the paper is pulled away, it will be seen that the color has been transferred to the canvas. Then a wet impression of another color is laid carefully in place so that it will register exactly, and the process is repeated, till all the colors have been transferred to the canvas.

The transferring can be done with the hand or with any other method, as no great power is needed, since the color transfers itself readily.

VI

STONE-PAPER

This is the name already generally adopted for a substitute invented by me for the Solenhofen stones.

I had been trying for a long time to invent some stone-like mixture that would be equally suitable for printing. The ordinary parchment of the writing-tablets would do if its surface were not soluble in water. I made considerable progress with a composition of lime and freshly congealed milk after the mixture had aged enough so that the lime could sate itself with oxygen. Then I made a composition of chalk, gypsum, and glue, which I dipped into a solution of nutgall and alum, and I was able to use this for coarser work, at least, if not too many impressions were required.

I did not get a wholly satisfactory idea, however, until I observed that fat spots that were caused on a stone by oil, and also designs that had been transferred to the stone with mere oil color, refused to take color after a few weeks if they were prepared in only the slightest degree.

I reasoned from this that oil suffered a change from exposure to air, and by combining itself presumably with oxygen acquired a more earthy character. This deduction may be correct or not; but it led me to experiment with oil as a binder for various earthy substances, because I reasoned that such a composition would be insoluble in water. The only question, then, would be if despite the intermixed oil it would permit itself to be prepared, that is, if it could be made resistant to other fats.

The result justified my hopes so thoroughly that I am convinced now that with various compositions of clay, chalk, linseed oil, and metallic oxides a stone-like mass can be made that is excellent for coating paper, linen, wood, metal, etc., and thus for making plates that not only replace the stone for printing, but in many cases are far superior to it.

I shall give the world a book soon about these fortunate attempts of mine, and thus perhaps give expert chemists an opportunity to perfect my invention still more.

VII

CHEMICAL PRINT ON METAL PLATES

All metals have great inclination for fats; but if they are quite clean, being ground with pumice, for instance, or rubbed-down with chalk, they can be prepared like a stone, that is, they acquire the property of resisting oil color, thus becoming available for chemical printing.

Iron and zinc can be prepared like the stone with aquafortis and gum.

To prepare zinc and lead, aquafortis with nutgall and gum will serve, but a slight admixture of blue vitriol will make still a better preparation, and this in a degree that improves according to the amount of copper that the surface acquires from the coating. The most durable preparation for lead and zinc is a mixture of aquafortis, gum, and nitrate of copper.

Brass and copper are best prepared with aquafortis, gum, and nitrate of lime, all mixed in proper proportions.

Lime and gum are a good preparation for all metals; also potash with salt and gum.

This alkaline preparation, however, is applicable only for the intaglio style. For the relief style, the acids are better.

Recently I have applied chemical printing from metal plates to a new form of copying-machines, with which everything written or drawn with chemical ink or crayon on paper can be transferred in a few moments and manifolded several hundred times. His Royal Majesty of Bavaria has had the supreme condescension to grant me a six years' patent on this invention.

Until now I have not been able to give this matter the necessary attention because the work of publishing this book hindered me; but now I shall make such a stock of these simple, convenient, and so widely useful hand-presses that it will be worth while to open a subscription, which would enable me to sell them for a low price. This would please me best, as my highest reward would be the general use of my inventions, to fulfill which desire I have taken the utmost pains in this work.

In the last parts of the book I have gone less into details, merely because

I assume that those who have mastered the first parts of this work will not need many words to understand the rest.

If the demand for this perhaps prematurely announced book had not become so vehement lately that I could not possibly delay its publication any longer, I should have tried to produce sample illustrations that combine inner art value with good printing. As it is, I postpone this for a supplementary volume soon to appear, in which I shall occupy myself mainly with processes and methods not yet generally known, representing each by means of a true work of art. With which I now end my text-book, with the hearty wish that it will find many friends and create many good lithographers. This may God grant!

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